NAVAL POSTGRADUATE SCHOOL
Monterey, California

PREDICTORS OF AVIATION SERVICE SELECTION AMONG U.S. NAVAL ACADEMY GRADUATES

by

Mario Gonzalez

June 2003

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The purpose of this study is to investigate U.S. Naval Academy student predictors of aviation selection for graduates between 1995 and 2002. The main hypothesis is that the background characteristics that predict aviation selectees will differ from the characteristics that predict non-aviation selectees. Although prior research suggests that several characteristics (academic, cognitive, athletic, and personality traits) play an important role in predicting success in aviation, other research suggests that many of those characteristics have not been included in the service selection process at the Naval Academy.

Two empirical models were estimated to investigate this hypothesis. The models were used to determine whether the significance of predictive factors differ between all aviation selectees and non-aviation selectees, and likewise between pilot aviation selectees and non-pilot aviation selectees.

The results show that of all of the variables in both models PFAR (an ASTB score) was the most important factor in predicting aviation selection. Both PFAR and academic grade point average at USNA had a large impact on aviation selection and separately on pilot selection. These results were representative of both aviation and pilot selection. It is also important to note that some variables were strong negative predictors in the models, although prior research suggested they would be positive predictors of aviation success. Apparently, the factors that predict success in aviation flight training are not the same that predict selection of the aviation community.

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PREDICTORS OF AVIATION SERVICE SELECTION AMONG U.S. NAVAL ACADEMY GRADUATES

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I. INTRODUCTION

A. BACKGROUND

What makes a "good pilot"? Are there measurable attributes such as cognitive ability or athletic agility? Are the important characteristics ones that can be learned or are they simply inherited? The answer to those questions have been the focus of numerous research studies conducted over the past six decades. Accurate prediction of pilot performance is particularly important for the U.S. Armed Forces, with the cost of aviation training approaching one million dollars per pilot (Reinhart, 1998; Fuchs, 2000; Arnold, 2002; Gallardo, Ireland, Pittman & Hampton, 2002). In effort to make the pilot accession pipeline as efficient as possible, the U.S. Government has invested a great deal of money and resources towards predicting who makes successful aviators.

Historically, the U.S. Air Force has exerted the greatest efforts towards streamlining their selection process. Weeks (2000) conducted an in depth research project focusing on all points of entry and accession sources for the U.S. Air Force. His central conclusion was that the "Air Force Academy (AFA) and Reserve Officer Training Corps (ROTC) pilot selection policies may have combined with training factors to increase attrition and flying training costs" (Weeks, 2000, p. v). In essence, he noted that current pilot candidate ability levels were lower on average than what they would be if selection policies assigned equal importance to officership and ability. Each of the Air Force commissioning programs maintained its own selection and qualification standards and none directly correlated with the most widely documented predictors of aviation flight training success. The results of his work suggested that each of the processes could be better improved so as to increase the overall cost effectiveness of the Air Force pilot selection process (Weeks, 2000).

Likewise, the Navy must look at its individual processes and assess the degree to which it is producing successful aviators. The single largest source of Naval Aviators is the U.S. Naval Academy (Bowman, 1995; Reis, 2000). That being the case, the selection process at USNA should represent the most accurate selection process of all the accession sources. The U.S. Naval Academy has historically produced graduates with a higher

statistical chance of success in flight school as compared to OCS and ROTC. While this is often attributed to the rigorous screening process for initial admission into USNA, it appears that the selection process may be improved even further (Griffin & Mosko, 1977; Reinhart, 1998). Improvements of the selection process could reduce the training costs of future pilots.

The cost of training Naval Aviators is extremely high. In 1998, the average cost of training was $500,000 per jet pilot. In an effort to improve the cost effectiveness of pilot training, the U.S. Navy has taken several measures to minimize the number of persons who fail to complete training (Reinhart, 1998). The initial aviation selection process has been a focus point of these efforts. The U.S. Naval Academy, like all accession programs, has continually improved its selection process in an effort to best fit graduating candidates into their prospective career paths. At the USNA, this selection process is known as "service assignment."

The United States Naval Academy service assignment process is charged with selecting young men and women who will become effective and valuable commissioned officers in their prospective communities within the Navy or Marine Corps. This is a complex and difficult task. The young adults who enter the Naval Academy come from diverse ethnic, religious, racial, and academic backgrounds. No two midshipmen have the exact same experience or background. Differences exist in academic major, athletics, leadership experiences, summer training experiences, etc. In the end, all midshipmen are expected to be equally prepared as future leaders in the Navy and Marine Corps, but that is not always the case.

Prior to graduation, midshipmen select their future careers in a process known as "service assignment." The service assignment process at USNA has been an evolutionary process. Historically, the order of First Class midshipmen would select their careers in a process known as "service selection." This process enabled midshipmen to select their careers based solely on a cumulative multiple known as Order of Merit (OOM). Midshipmen with a "high" OOM would get their choice of careers while those with "low" OOM would be forced to select from what was left over.

Since 1995, "service selection" has become "service assignment" and instead of basing the procedure entirely on Order of Merit, midshipmen now go through an involved interview process as well. The interview panel's purpose is to select the best-suited candidates for their perspective warfare specialties and to identify those midshipmen who they believe would not be successful. As a result, on Service Assignment Night midshipmen are told what they have been assigned, rather than getting to select what they want at that point.

While the service assignment process has been refined through the years, it is the central argument of this research project that it may still be improved. In order to minimize attrition during flight training and increase the success of future pilots, the selection process should focus more on specific predictive characteristics. The primary purpose of this thesis is to investigate specific U.S. Naval Academy student predictors of aviation selection. Additionally, through the literature we will compare and contrast those measures with predictors of success from several different aspects of aviation.

B. PURPOSE

It is unknown if the current methods of aviation service assignment at the U.S. Naval Academy are producing Naval officers who can successfully complete Naval Flight School. Furthermore, it is unknown if there exist common characteristics among midshipmen that select Naval aviation as compared to those who select other careers. In an attempt to assist the Office of Institutional Research at USNA in researching this topic, this thesis will examine U.S. Naval Academy graduates from 1995 to 2002 in effort to determine if there are characteristics that may be statistically reliable in predicting which USNA graduates select Naval Aviation.

C. SCOPE AND METHODOLOGY

As stated earlier, it is unknown if the current methods of Aviation service assignment at USNA are producing Naval officers who can successfully complete Naval Flight School. This project will review academic, cognitive, athletic, demographic, and historical measures of a set of midshipmen who graduated between 1995 and 2002. The

thesis will investigate the relationship between each characteristic and aviation service selection as compared to non-aviation selection. Furthermore, this thesis will compare the results to the successful predictors that have been formed in the literature.

The results should provide useful information to both the Service Assignment Boards as well as the incoming classes at USNA, specifically those desiring future careers in Naval Aviation. This information can be used in two ways. First, it could be used to guide the academic and military careers of midshipmen in an effort to increase their chances of selecting an aviation billet. Secondly, it may further solidify the aviation assignment process at USNA such that selectees have an increased statistical probability of success as Naval Aviators.

The scope of the thesis will include: (1) a review of the service assignment process at USNA; (2) a review of current predictors of aviation performance; (3) a data analysis of Naval Academy graduates for class years between 1995 and 2002; (4) and an investigation of relationships between measures and predictions of group membership (aviation selection).

This study will be limited to the population of USNA students who graduated between 1995 and 2002. The data does not include any field relating to "midshipman intent." In other words, this study is incapable of measuring the personal desire or drives, either quantitatively or qualitatively, of any midshipmen toward a specific career path. Less than one percent of midshipmen were deleted from this study due to ambiguous data with regards to graduation status or career selection.

The methodology used in this thesis research consisted of the following steps.

1. Conducted literature review.
2. Conducted a thorough review of service assignment procedures.
3. Performed descriptive frequency analyses of characteristics.
4. Performed descriptive cross-tab analyses of characteristics.
5. Performed descriptive means analyses of characteristics.
6. Performed logit regression analyses to investigate the predictability of group membership, and estimated logit models to determine relative importance of variables.
7. Displayed results of descriptives and other analyses in graphical form for ease of understanding.

D. ORGANIZATION

This study is divided into five chapters and includes several appendices. Chapter I provides an introduction and background for the broad understanding of the relevance of the subject matter. Chapter II reviews pertinent literature related to the process of selection and the status of Naval Academy pilot selection. Chapter III provides a detailed description of the variables, data fields and methodology used in the study. Chapter IV presents the empirical findings of the analyses. Finally, Chapter V summarizes conclusions from the findings as well as provides recommendations and suggestions for future research.

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II. BACKGROUND AND LITERATURE REVIEW

A. BACKGROUND

1. Service Assignment at USNA

The Service Selection Process at USNA has been an evolutionary process. Historically, First Class midshipmen would line up on Service Assignment Night in numerical grade point average (OOM) order and as their numbers were called they would have the opportunity to select whatever was available. Logically, the early numbers had freedom to select whatever profession they wanted, and the later numbers got whatever was left.

2. Current Assignment Procedures

More recently, the Naval Academy has adopted a more involved selection process that in many ways mirror job selection processes in the civilian sector. Beginning in 1995, "service selection" became "service assignment." Instead of basing the procedure entirely on Order of Merit (OOM), midshipmen now go through an involved interview process as well (Larson, 1996). Despite the changes in the service assignment process, the overall purpose remains to select "the best qualified midshipmen for each available billet" (Allen, 2002).

a. The Interview Process

The improved service assignment procedure incorporates an involved interview process. The interview panel is comprised of one senior officer from the midshipmen's prospective community, and two other junior officers (Allen, 2002; Watson, 2002). Like many civilian sector interview processes, the panel attempts to accomplish the "best fit" between midshipmen and the future job position they will hold. The formal purpose of the interviewing panel is to:

> Recommend for commissioning as Ensigns, Student Naval Aviators (1395) those midshipmen whom a majority of the members consider best qualified, giving due consideration to the needs of the Navy for officers with particular skills (Ryan, 2002, p.1).

In order to best identify these "particular skills," specific parts of the interview process as well as the specific questions asked by board members have varied slightly over the years. While the overall purpose of the interview process has not been affected by these changes, it appears that they have changed how aviators have been selected. In essence, every time the process changes, a different product is produced. Despite its changes over the past few years, the interviewing panel has continued to evaluate midshipmen in five broad areas:

1. Appearance and Poise
2. Oral Communication and Expression of Ideas
3. Leadership Potential
4. Community Motivation
5. Community Understanding

b. Community Assignment Boards

After the interview process, the midshipman's OOM and interview score are combined to make up his or her final "service assignment multiple" (SAM). That multiple is then used by the Administrative Service Assignment Boards to further evaluate midshipmen, prior to assigning them to prospective communities. The Aviation Community Screening Board incorporates a multitude of information and is tasked with making "recommendations for the assignment of individual midshipmen to the community for which they are best qualified" (Watson, 2002, p. 1).

In the past seven years, the weight of the interview in the final service assignment multiple has fluctuated slightly but the emphasis has historically been on OOM. Currently the ratio stands at 80 percent OOM and 20 percent interview score (Roberge, personal communication, 19 July 2002). At the completion of this process, an Executive Review Board recommends midshipmen to the Superintendent for final assignment in accordance with specific ceiling caps for each community (Chief of Naval Operations 1995; Allen, 2002; Ryan, 2002;).

c. Assignment

The entire service assignment process takes place during the midshipman's senior year at the Naval Academy. At the beginning of this process, midshipmen indicate their personal career preferences in order of desire, with first choice

being their most desired community. It is not until the January or February timeframe that midshipmen are notified of their assignments. Historically, 90 percent to 95 percent receive their first career choice on Service Assignment Night. The night represents the culminating point for a midshipmen's career and the finalization of the assignment process. After this point, very few exceptions are made to change career assignments (Allen, 2002).

d. The Journey

Regardless of the continual improvements made to this process, two factors seem to prevail. First, midshipmen have no guarantees of selecting their desired professional fields. Despite four years of difficult work and in many cases a lifetime of aspirations, it is not until service assignment night that they are certain what their future holds. Conversely, in most civilian job sectors, people train and prepare themselves for specific jobs, particularly those specialties known to require proficiency in special aptitudes. More often than not, people do not apply for several task specific jobs such as flying planes, driving ships or submarines, and gladly take whatever they are accepted for. In actuality, the assignments into comparable civilian sector jobs normally come after a great deal of specific preparation (Office of Under Secretary of Defense, 1999). For instance, a person applying for a labor management position may not be properly prepared to fill the position of a data management specialist, or vice versa. In essence, the selection process may overlook candidates who are best prepared for aviation careers, but do not screen high enough to be considered.

Secondly, despite the rigors of the selection process, flight school attrition continues to be an important issue. Students selected as the "best qualified," under current standards, continue to fail out of initial flight training. The Chief of Naval Air Training described current selection standards as "inadequate" and recently incorporated the Introductory Flight Screening (IFS) Program to better prepare those men and women who were selected as aviators (Carey, 2002, p. 2). This program was "initiated to decrease flight-related attrition and drop-on-request (DOR) rates in primary flight training by identifying SNPs who lack either the determination, motivation, or aeronautical adaptability required to succeed in training" (Carey, 2002, p. 2). The

existence of this program suggests that further refinements can be made to the selection process in order to reduce flight school attrition.

In essence, midshipmen often come to the Academy with aspirations of entering specific communities within the Navy or Marine Corps. Others develop these desires along the way. Despite many of the tireless efforts to pursue these aspirations, many midshipmen may not select the field they desire or mentally and physically prepared themselves to enter. Additionally, the service assignment process remains as a great mystery to midshipmen. The regulations state that midshipmen assignments are subject to the "needs of the Navy" and "community(s) for which they are best qualified" (Allen, 2002, p. 1). More often then not, midshipmen are left guessing about their futures until the selections are announced on Service Assignment Night.

While the first-class aviation selection process is under constant improvement, the midshipmen clearly begin their journeys toward selection much sooner then their senior year at USNA. Additionally, according to the Chief of Naval Education and Training (CNET), current pilot selection methods at USNA and other commissioning sources are not adequately producing successful aviation candidates. The primary consideration of this project is to investigate the significance of specific academic characteristics as predictors of U.S. Naval Academy aviation selection.

B. SUCESSFUL AVIATOR PREDICTION

1. Purpose / Cost Savings

Training Naval Aviators is the most costly training pipeline in the Navy. With an average cost of $500,000 per jet pilot, the U.S. Navy has taken several measures to minimize the number of persons who fail to make it through training (Reinhart, 1998). For years, the Air Force Academy has invested a significant amount of money in its aviation candidates, in hopes to reduce flight school attrition. Each prospective pilot achieves the equivalency of his or her private pilot license (50 hrs of instruction including solo flight), to ensure flight aptitude, prior to beginning flight school (Department of Air Force, 2002). As stated earlier, the Navy and Marine Corps recently implemented a similar initial flight training program. This new addition, entitled the "Introductory

Flight Screening (IFS) Program" was established for all USNA, NROTC, and Marine Corps aviation selectees (Carey, 2002). This program consists of 25 flight hours to provide a foundation for all Academy graduates selecting aviation. The Marine Corps estimates initial flight training will cost $4,000 per perspective pilot, but considers it a small price compared to the cost of a student who attrites from flight school (Larson, 2002). Reinhart (1998) indicated that a student attriting from Naval Flight School costs between $18,000 and $500,000 depending upon how far along in the training they were before dismissal. All these programs have justified the initial investment costs as a preventive measure of flight school attrition. Reinhart (1998) was but one of many researchers to conclude that prior flight experience positively influenced Primary Flight School performance.

Congress has recently begun to allocate funds focused on beginning aviation flight training much earlier than the traditional undergraduate level. It is believed that early development of specific aviation-related attributes will further improve aviation training success rates. Along with additional funding provided to Academy graduates, in 2001 Congress approved $1 million of aviation training funds to be allocated for Naval Sea Cadets. These funds are designed to provide high school students the opportunity to receive initial flight ground school training at Pax River, Maryland (Lejeune, 2001). While small amounts of resources are being focused toward early aviation accession programs, like the Sea Cadets, the majority of the resources and research remains centered around the prediction of college graduate candidates.

Today, the single most valued aviation predictive measure in the Navy is a paper-and-pencil test named the Aviation Selection Test Battery (ASTB). The research and development of this cognitive ability test continues to be the focus of most budgeting efforts. As a result of the current emphasis on the ASTB, estimated savings realized from reduced training and attrition rates is in excess of $20 million annually (Arnold, 2002).

2. Commercial Pilot Selection

Commercial aviation uses pilot selection methods, similar to the military, to facilitate their employment specifications. Although most of the published research on aviation selection deals primarily with the military, some recent studies have focused on

its commercial counterparts. Unlike military aviation, commercial institutions primarily try to select experienced pilots, most of which have military backgrounds. This allows them to focus selection efforts around interviews and high-fidelity simulators, rather than relying on other less predictive measures such as cognitive ability tests (Carretta & Ree, 2000). As the pool of trained military aviators is lessening, commercial aviation may be forced to adopt more inclusive selection methods, similar to military aviation.

a. U. S. Carriers

U.S. commercial carriers have recently shown noticeable interest in assessing the reliability of their own selection methods. For instance, the Federal Aviation Administration (FAA) conducted in-depth research projects, focused on the selection and hiring trends of U. S. carriers, in both 1994 (Suarez, Barborek, Kikore, & Hunter, 1994) and again in 1997 (Carretta & Ree, 2000). While these studies investigated the actual procedures being used, they did not attempt to assess the validly of any the observed methods (Carretta & Ree, 2000).

U.S. carriers reportedly used various types of hiring techniques and selection methods. Included in these methods were: interviews, aptitude tests, flight checks, simulators, clinical psychological assessments, reference checks, and biographical checks (Carretta & Ree, 2000; and Hedge, Bruskiewicz, Borman, Hansan, & Logan, 2000). The degree to which these methods were used differed among carriers. The most commonly used methods among regional and major U.S. carriers were reference checks, background checks, interviews, and simulators (Carretta & Ree, 2000). The actual "ability to fly" was not a major determining factor for these larger carriers as their primary source of pilots was prior military or other experienced aviators.

Conversely, smaller carriers tended to focus more on actual flight skills. They also relied heavily on prior experienced aviators and focused little attention on overall aptitude tests and psychological assessment measures. Likewise, larger carriers placed little emphasis on psychological assessments, aptitude tests and other predictive flight skill methods (Carretta & Ree, 2000).

In essence, the selection methods used varied remarkably from carrier to carrier. "Researchers and practitioners in pilot selection spend most of their effort on

identifying crucial pilot abilities and characteristics and ways to measure them" (Carretta & Ree, 2000, p. 16). Arguably commercial carriers need not focus much attention in this arena since the majority of pilots they hire have already been screened by the military. Likewise, recent research suggests that "many U.S. major and regional airlines are uncertain about how to use psychological (and other) testing as a tool to help determine the type of pilots they want to hire" (Fiorino, 2000, p. 19). Thus, the emphasis on accurate prediction and selection of pilots remains on the military.

b. Non-U.S. Carriers

The scientific data regarding non-U.S. commercial carriers is even scarcer. While several studies have investigated non-U.S. commercial pilot selection, (Manzey, Hormann, Osnabrugge, & Goeters, 1990; Stahlberg & Hormann, 1993; Doat, 1995; Bartram & Baxter, 1996; Horman & Lou, 1999; and Novis Soto, 1998) their focus offered little information with regard to the validity of these methods. Overall, they displayed a wide range of selection techniques. Likewise, different carriers placed differing amounts of emphasis on different methods.

These carriers used selection methods similar to U.S. carriers, of interviews, skill level testing, aptitude testing, and medical screening (Carretta & Ree, 2000; Swissair Pilot Selection, 2000). They too however, relied heavily on hiring experienced pilots for starting positions instead of *ab intro* training. Likewise, it was understandable that commercial aviation in general, relied heavily on the military to produce capable pilots.

3. Allied Nations Pilot Selection Methods

a. Historically

Prior to World War I, Italy distinguished itself with the first recorded pilot selection research program. The Italians used measures of reaction time, emotional reaction, equilibrium, perception of muscular effort, and attention. Shortly thereafter, the French began researching similar measures including reaction time and emotional stability (Carretta & Ree, 2000).

During the World War I era, researchers began to conclude that measures of intelligence were valid predictors of pilot training success, at the time. Between the

two World Wars, much of the foreign research developed around an American-based aviation selection exam that served as a general mental-battery testing comprehension and reasoning. Shortly before WW II, several American test batteries had been constructed to measure general cognitive aptitudes (Carretta & Ree, 2000).

"WWII brought a renewed interest in pilot selection" (Carretta & Ree, 2000, p.19) The American Army led the development of several ability measures for pilot selection in what became known as the U.S. Army Air Corps aviation psychomotor tests. These tests, in turn, served as a foundation for much of the British and Canadian pilot selection methods. Furthermore, the Germans used many of the allied methods in selecting their own pilots. Similarly it is known that the Japanese also during WWII, used tests "based on the American Army Alpha, and a paper-and-pencil derivative of the Binet intelligence test" (Carretta & Ree, 2000, p.19).

During the quarter century following WWII, little progress was made to change pilot selection methods by any nation. Most countries spent the majority of their efforts refining paper-and-pencil models of existing tests. Beginning in the 1970's the field of personality measurement began to take the forefront of research innovation. Since then, multiple aptitudes and psychomotor abilities have been measured by countries across the globe (Manzey, Hormann, Osnabrugge, & Goeters, 1990; Burke, 1993; Stahlberg & Hormann, 1993; Suarez, Barborek, Kikore, & Hunter, 1994; Doat, 1995; Bartman & Baxter, 1996; Novis Soto, 1998; Horman & Lou, 1999; Carretta & Ree, 2000; and Swissair Pilot Selection, 2000).

b. Current Practices in NATO

"Pilot selection procedures used in NATO-member countries vary in content, focus, and method of administration. However, all NATO-member countries employ some form of psychometric testing as part of military pilot selection" (Burke, 1993; Carretta & Ree, 2000, p. 19). Historically, the Royal Air Force (RAF) pilot selection methods rely heavily on ability for job specialties and on measures of personality, character, and biographical information. The current RAF pilot aptitude composite examination samples several particular areas: anticipatory and compensatory

tracking, interpretation of aircraft instruments, reasoning, mental speed, monitoring and attention, as well as short term memory.

4. Air Force Selection Methods

While no nation or single aviation entity appears to have solved the pilot prediction problem completely, the U.S. Air Force has arguably advanced further than all other programs. The U.S. Air Force (USAF) pilot selection procedures have changed substantially in the last few years. Their programs have been augmented with numerous state-of-the-art aptitude tests including the use of significant computer-based assessments (Carretta, 2000). Furthermore, USAF training procedures have also matured in an effort to modernize the training fleet and provide better, more specialized training earlier in the training process (Carretta, 2000).

a. USAF Pilot Qualification

Similar to the U.S. Navy, the "U.S. Air Force pilot qualification standards include medical fitness, anthropometric standards, educational achievement (e.g., college grade point average, major), and for some commissioning sources, aptitude test scores and successful performance in a flight screening program" (Carretta, 2000, p. 19). Likewise, the indicators of pilot aptitude used vary by source of commission. Moreover, pilot aptitude test scores are used to express qualification minimums for some points of entry, although the manner in which these scores are used by selection boards varies (Carretta, 2000).

b. USAF Pilot Aptitude Tests

The two most widely used pilot aptitude tests in the USAF are the Air Force Officer Qualifying Test (AFOQT) and the Basic Attributes Test (BAT) (Carretta, 2000). The AFOQT is a paper-and-pencil multiple aptitude battery used for officer commissioning and aircrew selection, consisting of sixteen sub-tests (Carretta, 2000; Weeks, 2000). It is designed to measure general cognitive ability (g), verbal, math, spatial, aviation knowledge, and perceptual speed (Carretta, 2000). The sixteen individual tests are combined into five composites: Verbal, Quantitative, Academic Aptitude (Verbal + Quantitative), Pilot, and Navigator-Technical. Additionally, the AFOQT "pilot composite" consists of eight tests that measure knowledge of aviation and mechanical

systems, the ability to determine aircraft attitude from flight instruments, knowledge of aeronautical concepts, ability to read and interpret scales and tables, and spatial ability (Carretta, 2000).

The Basic Attributes Test (BAT) is a computer-based battery composed of five individual tests, used solely for pilot selection. Among its measures are: cognitive ability, psychomotor ability, and attitudes toward risk (Carretta, 2000). The Air Force introduced the BAT in 1993 and has continued its use until today. A combination of scores from the BAT, the AFOQT pilot composite, and a measure of flying experience are used to produce a pilot aptitude composite known as Pilot Selection Method (PCSM). Research shows a strong relationship between PCSM scores and the probability of completing UPT, number of flying hours needed to complete training, class ranking, and fighter qualification (Carretta, 2000). In fact, "higher PCSM scores are associated with greater probability of completing jet training, fewer hours needed to complete training, higher class rank, and greater likelihood of being fighter qualified" (Carretta, 2000, p. 4).

c. USAF Flight Screening Program

In addition to the multitude of predictive measures the Air Force uses in pilot selection, it has recently modified its initial flight screening program. The U.S. Air Force has long since acknowledged the value of actual flight experience prior to selecting individuals for future training. By the early 1990's the Flight Screening Program (FSP) was already well developed. In 1994, the FSP expanded from about 14 hours of instruction in the T-41 to almost 21 hours in the T-3 (Slingsby Firefly) (Carretta, 2000). This Enhanced Flight Screening Program (EFSP) included more aerobatics training and was popular with students and instructors. However, in July 1997 the T-3 flight operations were suspended following several uncommanded engine stoppages (Carretta, 2000, p. 4).

The suspension of T-3 training caused many students to arrive at SUPT training (Air Force equivalent of Navy primary flight training) with no hands-on flying experience. The difficulties encountered by student and instructors were evident immediately. "Even students who had prior flying time in commercial aircraft were sometimes having problems adapting to military flight procedures. Without the benefit of

T-3 flight screening, attrition rates for SUPT climbed above 15 percent" (Carretta, 2000, p. 4). The USAF considers an 8 to 10 percent attrition rate acceptable.

These dramatic increases in attrition solidified the Air Forces' opinion toward initial flight training. As a result, in October 1998 the USAF implemented an Introductory Flight Training (IFT) program. The IFT program includes up to 40 hours flying time in commercial aviation training programs and requires at least one solo flight. "The 40-hour IFT program reportedly has produced similar attrition rates in the T-37 phase of SUPT as were observed when EFSP was in use (IFT — 8.8% vs. EFSP — 7.8%)" (Carretta, 2000, p. 4).

Additionally, in October 1999, the USAF announced plans to implement an expanded IFT program (Carretta, 2000). The expanded program increased hands-on flying time to 50 hours and requires additional solo flights and students to earn a private pilot's license. In the expanded IFT program, students receive Federal Aviation Administration-certified flight instruction through local flight schools. In effort to implement IFT amongst all the Air Force officer sources, more than 150 flight schools nationwide may be involved (Carretta, 2000).

d. USAF Continual Improvement

The U.S. Air Force continues to assess the validity of its pilot selection processes. Recently, The Air Force conducted a "policy capturing exercise" to better understand the process by which the AFA, Active Duty, OTS, and ROTC pilot selection boards make their decisions (Carretta, 2000; Weeks, 2000). The results of this study and other cumulative research suggest that U.S. Air Force "pilot selection decisions could be improved simply by making better use of currently available personnel attribute data" (Carretta, 2000, p. 10).

Additionally, despite several studies showing the utility of USAF pilot aptitude tests for predicting training performance, results suggest that this information is often ignored by pilot candidate selection boards (Carretta, 2000; Weeks, 2000). In fact, results also showed that the two largest sources of USAF pilot trainees relied heavily on measures of officership, when making selection decisions, rather than proven predictive measures (Weeks, 2000).

Finally, "cumulative research findings suggest that USAF pilot selection decisions could be improved by making better use of currently available personnel attribute data" (Carretta, 2000, p.1). Specific recommendations suggest that further improvements could be expected from the addition of a structured selection interview and including specific personality measures (Carretta, 2000; Weeks, 2000). Likewise, it stands to reason that the U.S. Navy and the US Naval Academy could improve their pilot selection techniques in a similar fashion.

5. Conclusions

By observing many different aspects of aviation it is understood that a variety of pilot selection methods exist. Commercial aviation tends to rely more heavily on recruiting and hiring experienced pilots while most military institutions conduct *ab intro* training. Thus, proper prediction of aviation training success is vital to the military aviation selection processes. For this reason, the U.S. Air Force has continued to lead the U.S. military's research and development efforts toward successful pilot prediction.

C. CURRENT U.S. NAVY RESEARCH AND PROCEDURES

Research regarding naval aviator selection and prediction began in 1939 in what was known as the Pensacola Project (United States Naval Flight Surgeon's Manual, 1991; Arnold, 2002). The project evolved into a small band of researchers known as Aerospace Experimental Psychologists (AEPs) from the Naval Aerospace Medical Institute (NAMI) who began studying over 30 different psychological tests as possible predictors of naval flight student performance (Arnold, 2002). Since 1939 that research has continued to be the primary focus of NAMI, now a detachment of the Naval Operational Medicine Institute (NOMI).

As a direct result of their ongoing research, the U.S. Navy recently developed the Pilot Predicting System (PPS). This research effort was designed to provide Navy managers and other decision makers with improved selection instruments (Blower, 1998). Similar screening mechanisms exist in the U.S. Air Force and the U.S. Marine Corps, with the Air Force's being by far the most extensive and costly system. Common to all

programs, is a rigorous flight physical screening process and at least one cognitive ability test designed to predict one's aviation aptitude.

1. Current USN Policy

The process of adequately measuring a pilot's aptitude is a difficult task. The "present policy of the Aviator Recruiting Command is to recruit those individuals most likely to succeed in the flight training program" (Reis, 2000, p. 37). In an ideal theory, an aviator is selected based upon many specific characteristics, all of which have been proven to have a direct relationship to success in training and the operational environment. Research suggests that these measures would include "physical, psychomotor and mental ability, and psychological (personality) requirements" (Pohlman & Fletcher, 1999, p. 284). Currently, CNET suggests that the selection processes used by the U.S. Naval academy, as well as other ascension sources, are "inadequate" (Carey, 2002, p. 2). Thus a thorough investigation of the procedures used by the U.S. Naval Academy may improve the overall success of selected aviators.

The Academy has access to a broad spectrum of personal data on each prospective pilot. For example: grades, military performance, academic major, standard cognitive ability test scores, among others, are all readily available to selection boards. Additionally, personal interviews are conducted with each candidate. Although high-tech computer-based methods are not employed at USNA, several improvements may be made by modeling known predictive characteristics.

2. Predictive Measures

A significant amount of literature suggests that several characteristics (academic, cognitive, athletic, personality traits) play an important role in the predictability of success in primary flight training (Reinhart, 1998; Pohlman & Fletcher, 1999; Carretta, 2000; Hedge, Bruskiewicz, Borman, Hansan, & Logan, 2000; Reis, 2000; and Weeks, 2000). In fact, for years the U.S. Navy has been using several cognitive ability tests, such as the Academic Qualifying Test / Flight Aptitude Rating (AQT/FAR) and the Aviation Selection Test Battery (ASTB) (similar to the Air Force's AFOQT) to predict aviation aptitude and success (Biggerstaff, 1998; Blower, 2000; Williams, 2000; and Arnold, 2002). These tests have been incorporated into the USNA aviation selection process for

some time, but have varied in significance from year to year (Roberge, personal communication, 19 July 2002; and Lata, personal communication, 02 October, 2002).

a. Physical Ability and Experience

Research suggests that success in flight training relies heavily on measurable psychomotor skills (Hunter, 1989; English & Rodgers, 1992; Reinhart, 1998; Pohlman & Fletcher, 1999; Carretta, 2000; Hedge, Bruskiewicz, Borman, Hansan, & Logan, 2000; Reis, 2000; and Weeks, 2000). While some correlations exist between pure athletic ability and pilot performance, specific skills are most easily quantified by the use of aviation simulators. Currently, the U.S. Navy, unlike the U.S. Air Force, does not employ any computer-based simulators in the pilot selection process. Research and development projects are currently being conducted to investigate the cost-effectiveness of such items (Weeks, 2000).

Prior experience also plays a large part in pilot success. In addition to the obvious importance of prior flight experience, some research suggests that "legacy" information is also predictive of pilot success among naval aviators (Reinhart, 1998; Reis, 2000; Mishoe, 2000). Candidates with prior military enculturation show a higher propensity for success in aviation careers (Mishoe, 2000). While it is not clear why this correlation exists, research suggests that these candidates possess higher levels of commitment as well as greater desires to succeed.

b. Academics

Several of the most researched predictors of aviation success are anchored in the realm of academia. Historically, the service academies have adjusted their curricula toward meeting the demands of technologically advancing warfare specialties (Masland, Radway, & Lovell 1957; Lovell, 1979). A greater emphasis was once placed on engineering, math, and science courses at both the Navy and Air Force Academies. Today's graduates from the Naval Academy earn a Bachelor's of Science degree in their respective fields. This is a testament that there continues to be a significant focus on the importance of technical oriented core curricula.

Likewise, many other aspects of academia may be observed with respect to their possible predictability of aviation selection. Research suggests that academic

performance and Primary Flight Training grades are significantly correlated (Reinhart, 1998). Further research also suggests that specific academic majors during undergraduate study may also be a contributing factor. Reis (2000) found that aviators with engineering degrees had a greater propensity for flight school completion than other technical or non-technical counterparts. Currently, these and other results continue to influence the Aviation Recruiting Command to place particular emphasis on recruiting individuals having "technical" undergraduate majors (Reis, 2000).

Additionally, at the U.S. Naval Academy, scholastic aptitude plays a considerable role in the process of aviation selection of midshipmen. Gremillion (1998) pointed out that midshipman academic performance was more crucial than physical fitness, conduct, or even military performance. He went on to explain how "strong academic performance" played a significant role in the Midshipman Leadership Position selection process. Both academics and leadership positions influence the Service Selection Board process. While prior literature may reveal the overall significance of academic performance, it is reasonable to believe the correlations between academia and aviation selection at the U.S. Naval Academy may differ from other institutions. Gremillion's (1998) evidence displayed the compounded influence on academic performance resulted in it being the most important factor in deciding the course of a midshipman's career.

Furthermore, several studies have investigated the importance of undergraduate education as a predictor of aviator success (Bowman, 1990; Reinhart, 1998; and Reis, 2000). Reis (2000) found that academic flight school success could partially be predicted by a student's major. He specifically pointed out that emphasis has been placed on recruiting individuals having "technical" undergraduate degrees. Not only did evidence directly relate specific types of majors with academic flight school success, it supported the conclusion that U.S. Naval Academy graduates have a higher success rate then ROTC or OCS counterparts (Bowman, 1990; and Reis, 2000).

Finally, these studies suggest that the realm of academia might encompass several predictors of aviation success. While each aspect is not completely reliable in

itself, it is reasonable to believe that the predictability of each academic factor may contribute to a larger model of successful aviation prediction.

c. Cognitive Ability

Throughout history the United States military has used general intelligence "g" or more recently referred to as "cognitive ability," as a predictor of performance in the realm of aviation (Pohlman & Fletcher, 1999). Although the utility of general measures of cognitive abilities have been well documented in the literature, their use for predicting pilot performance has not been without question. Critics of this approach argue that the relationship between intelligence and performance in aviation may be weak since it cannot adequately predict aircrew performance (Hunter, 1989; and Hedge, Bruskiewicz, Borman, Hansan, & Logan, 2000). However, these critics do acknowledge that specific cognitive abilities, required to meet unique job related tasks performed by pilots, may be predicted by these measures. Thus, the same critics that claim no correlation between intelligence and aviation performance concede that intelligence, in so far as it reflects aptitude for instrument comprehension and mechanical comprehension, is a good predictor (Hunter, 1989).

Within the U.S. Navy's prediction system lies one such cognitive ability test, the Aviation Selection Test Battery (ASTB). The ASTB was specifically designed as a cognitive measure of flight aptitude. Over the past few years it has become the most widely used and examined predictor of flight performance. Several studies have concluded specific portions are the single most reliable predictor of flight school success (Biggerstaff, 1998; Blower, Williams, & Albert 2000; and Williams, Albert, and Blower 2000). The U.S. Naval Academy has recognized the importance of ASTB scores in predicting flight school performance and has incorporated specific portions into the Service Selection Boards for student pilot selectees (Ryan, 2002).

3. The Aviation Selection Test Battery (ASTB)

"The U.S. Navy and Marine Corps Aviation Selection Test Battery (ASTB) is a paper-and-pencil type test used as the primary instrument for selecting student naval aviators (pilots), student naval flight officers (NFOs), and officer candidates for Officer Candidate School (OCS)" (United States Naval Flight Surgeon's Manual, 1991, p. 1). It

was designed to be an economical, accurate, and easily standardized selection tool for use throughout the Navy and Marine Corps (United States Naval Flight Surgeon's Manual, 1991). Although it is used differently by each aviation selection source, it remains the single most predictive tool in the inventory.

a. History of the ASTB

The current ASTB is the result of years of cognitive ability research and development efforts. During WWI, aviators were selected primarily by physical qualifications with little or no attention given to psychomotor skills or analytic ability. The result of this type of screening was extremely high attrition as well as tremendous pilot casualties due to human error. In turn, researchers recognized the need for more formalized pilot selection methods (United States Naval Flight Surgeon's Manual, 1991).

As a result, in 1939 the Civil Aeronautics Authority directed the National Research Council to devise a program designed to select candidates for a nationwide light plane training program (United States Naval Flight Surgeon's Manual, 1991). This led to the creation of the Medical Research Section of the Bureau of Aeronautics which later transferred their responsibilities to the Aviation Psychology Section of the Bureau of Medicine and Surgery (United States Naval Flight Surgeon's Manual, 1991). In all, the researchers invented, tested, manipulated and assessed the validity of several psychological tests for future pilot selection.

The technological advances of military aviation in WWII also brought about the necessity for increased successful pilot selection methods. As a result the "Pensacola 1000 Aviator Study" evaluated the predictability of three primary tests as well as ten other psychological, psychomotor, and physical tests (United States Naval Flight Surgeon's Manual, 1991). The results verified the validity and effectiveness of the three primary tests and displayed further usefulness of certain psychomotor devices in aviator prediction (United States Naval Flight Surgeon's Manual, 1991). Unfortunately, at that time the logistics of successfully administering all the separate tests among decentralized testing stations proved insurmountable and their utility was never implemented as the standard selection method.

Finally in 1942, one single test index was introduced. The Flight Aptitude Rating (FAR) was combination of a Mechanical Comprehension Test (MCT) and a Biographical Inventory (BI). Less than one year later it was combined with a successor of one of the original three Pensacola 1000 tests and became the (AQT/FAR). The AQT portion further incorporated a test of general intelligence which included judgment, arithmetic, vocabulary, meter reading, and checking skills (United States Naval Flight Surgeon's Manual, 1991). This test underwent revisions in 1953, which included a Spatial Apperception Test (SAT) and again in 1971 but continued to maintain high levels of predictability (United States Naval Flight Surgeon's Manual, 1991; and Reinhart, 1998). Consequently, its predictive validity suffered significantly following the transformation of the military to the "All Volunteer Force," advances in aviation technology, as well as revised federal employee hiring procedures redefined the pool of selectees (Reinhart, 1998). As a result, the AQT/FAR was replaced by the first generation of the ASTB.

In 1981, the management and operation of the aviation selection test program was assigned to the Naval Aerospace Medical Institute (NAMI) where it underwent several years of further research and development (United States Naval Flight Surgeon's Manual, 1991). The current version of the ASTB was developed by the Bureau of Medicine and Surgery (BUMED) in conjunction with Educational Testing Services of Princeton, New Jersey, and was last revised in 1992 (United States Naval Flight Surgeon's Manual, 1991; and Reinhart, 1998).

b. Description of the ASTB

The current ASTB consists of five paper-and-pencil sub-tests representative of four aptitude measures and one background questionnaire: Math-Verbal Test (MVT), Mechanical Comprehension Test (MCT), Spatial Apperception Test (SAT), Aviation and Nautical Test (AN), and the Biographical Inventory (BI). The actual tests are administered in two equivalent forms, in each of the testing facilities. The scores from each of the testing facilities are compiled by BUMED and disseminated via NAMI to each of the aviation candidate sources. Each source in turn weighs that information in accordance with their specific selection criteria (United States Naval Flight Surgeon's Manual, 1991).

c. Scoring of the ASTB

Throughout the fleet and Marine Corps, five ASTB scores are currently being used. Among those scores are: "The Academic Qualification Rating (AQR) score, the Flight Aptitude Rating (PFAR/FOFAR) score, for both pilot (PFAR) and NFO (FOFAR) and the Biographical Inventory (BI) rating for both pilot (PBI) and NFO (FOBI) (United States Naval Flight Surgeon's Manual, 1991, p. 2). The AQR serves as a general aptitude test and has been proven to be predictive of ground school performance. The PFAR/FOFAR scores represent a combination of scores on the MVT, MCT, ANT, and SAT for pilot candidates (P) and flight officer candidates (FO), respectively (United States Naval Flight Surgeon's Manual, 1991). These specific tests measure familiarity with mechanical concepts in addition to the ability to visualize plane-to-terrain attitude relationships. The PFAR/FOFAR scores have been proven to be predictive of success or failure in the flight training program (United States Naval Flight Surgeon's Manual, 1991). Finally, the Biographical Inventory section assesses personal history of applicants. Other scores from this test are also used as screening mechanisms for some non-aviation officer programs.

d. Minimum Qualification Scores on the ASTB

For the purposes of pilot selection only three scores are considered: the AQR, PFAR, and PBI. As of April 2002, the PBI scores are no longer being used as part of the minimum qualification standards (United States Naval Flight Surgeon's Manual, 1991, and Arnold, 2002). Candidates' performance on the AQR, PFAR/FOFAR and PBI/FOBI is scaled in "stanines", or "standard nines." This stanine scale represents a condensed form of the T-scale. Stanine scores span three standard deviations on either side of the mean in a standard normal distribution, but still range from 1 to 9 with a mean of 5.

Before April 2002, the minimum qualifying ASTB score for a Navy Pilot was 3/4/4 (AQR/PFAR/PBI). Currently, the minimum qualifying score is 3/4 (AQR/PFAR) (Arnold, 2002; and Phillips, 2002). For purposes of this study, all candidates in the data set selected aviation prior to April 2002, so the initial qualification standards will be used.

e. Predictability of the ASTB

It goes without question that aviation selection tests play an important role in the screening of aviation candidates. The question lies in the reliability in only one measure. Those responsible for the ASTB feel that it is an excellent predictive measure. In fact, Dr. Blower (1998), of NAMI considers the ASTB to be part of "a statistical model that predicts whether a student will pass or fail in primary flight training as a function of four selection test scores and overall achievement in API" (Blower, 1998, p. 12). It remains the single most researched predictive measure of pilot prediction in the Navy and Marine Corps. For this reason, among others, it should play a significant role in the selection process of candidates from all sources.

4. Conclusions

Each year, approximately 10,000 individuals demonstrate an interest in professional military aviation by taking the U.S. Navy and Marine Corps Aviation Selection Test Battery (ASTB) (Williams, Albert, & Blower, 1999, and Arnold, 2002). Historically, of the 10,000 taking the ASTB, almost half fail to meet minimum selection scores. Furthermore, those who score favorably must then undergo a thorough physical examination to ensure that they meet medical standard. Approximately 25% fail the physical examination. Finally, candidates must ultimately pass the individual screening and interview processes as well. In reality, of those initially tested individuals, approximately 5% will ultimately be selected as "Student Naval Aviators" and begin training.

It is paramount that the small numbers who qualify possess the greatest probability of success. In an effort to ensure maximum success, it is necessary to base the selection process on the highest predictive measures possible. While the ASTB is considered to be the single most valuable tool in use today, its utility may be improved by complementing the selection process with additional selective measures. These measures may include academic, psychomotor, and biographical characteristics of each candidate.

D. MEASURES SPECIFIC TO USNA

1. Order of Merit (OOM)

Order of Merit (OOM) is the overall quantitative measure of a Naval Academy Midshpman's academic and military performance. It is comprised of adjusted composite scores in academic performance, physical education, athletic performance, military performance and conduct (Larson, 1996). Its academic composite is known as the Cumulative Quality Point Ratio (CQPR) while the military performance composite is known as the Military Quality Point Ratio (MQPR). Research suggests there is possibly no better predictor at USNA than OOM (Reinhart, 1998; Hafner, 2000; and Reis, 2000).

2. Cumulative Quality Point Ratio (CQPR)

The academic composite score (CQPR) represents the largest percentage of the OOM total scores (Larson, 1996). During a student's four-year academy experience, the CQPR represents approximately 64% of a midshipman's overall OOM. Thus, as past research shows, OOM is highly correlated to flight success (Reinhart, 1998; Hafner, 2000; and Reis, 2000), CQPR appears to be a second order predictor. In studying academics alone, Reinhart (1998) concluded there was a "direct relationship between the level of academic achievement at the academy and primary flight grades" (p. 74).

3. Military Quality Point Ratio (MQPR)

One arena that has been researched somewhat but has yet to be fully explained is the occurrence of military performance as a predictor. Military performance is the strongest predictor of aviation assignment at the U.S. Air Force Academy (Weeks, 2000). As for the studies done on U.S. Naval Academy, the decision is split. Some research says military performance is a strong predictor (Hafner, 2000), while others say it is inconclusive (Reinhart, 1998).

At the U.S. Naval Academy, the military performance composite of OOM is known as the Military Quality Point Ratio (MQPR). Although this topic remains debatable, this paper will investigate the importance MQPR as a predictor of aviation selection during 1995-2002.

4. Varsity Athletics

Research suggests that athletics, especially specific psychomotor skills, are highly predictive of aviation success (Hunter, 1989; English, 1992; Reinhart, 1998; Pohlman & Fletcher, 1999; Carretta, 2000; Hedge, Bruskiewicz, Borman, Hansan, & Logan, 2000;

Reis, 2000; and Weeks, 2000). Currently, it is unknown if raw athletic ability is predictable of aviation selection at USNA. All students are required to participate in basic athletic levels of competition but few actually become varsity-level athletes. This paper will investigate varsity athletics as one of several possible predictive characteristics of aviation selection at USNA.

5. Gender and Ethnicity

Research has additionally investigated group differences such as gender and ethnicity amongst flight school students. In essence, there is still a wide disparity on the predictability of both of these criteria. Carretta (1997a; 1997b) concluded there was no evidence of differential validity across demographic groups amongst U.S. Air Force flight students. Likewise, Reinhart (1998) concluded there were no gender or minority differences between naval flight school students. Conversely, Reis (2000) concluded that majority flight students achieved higher composite flight scores in comparison with minority students. While these topics remain inconclusive, research has suggested that although mean scores may differ slightly between groups, the overall tests used quantify the same flight related characteristics equally among different groups (Carretta, 1997b).

E. RESEARCH METHODS

The purpose of this study is to investigate U.S. Naval Academy student predictors of aviation selection for graduates between 1995 and 2002. In doing so, a theoretical model investigating several predictive characteristics of aviation selection at USNA will be examined. The relationship of "pilot selection" at USNA to OOM and its components, to undergraduate major, to ASTB scores, to family legacy, and to varsity athletics will all be investigated. To best examine these relationships a variety of statistical analyses will be performed.

The dependent variable in this study (aviation selection) has a binary outcome. Midshipmen either selected aviation or they did not. To best analyze the behavioral relationships between each of the independent variables on the binary dependent variable non-linear regression techniques are recommended (Bowman, 1998). Using Bowman's (1998) econometric theory and applying logistic regression techniques to this model, the

researcher will be able to observe the impact of each independent variable on the probability of the outcome of aviation selection occurring. Thus, the degree to which these characteristics predict group membership between aviators and non-aviators will be examined.

Furthermore, all statistical analysis will be conducted using SPSS v. 11.0 software. The SPSS software provides the means necessary to adequately describe the data, test the hypothesis, and examine relationships (Norusis, 1997; and Morgan, Griego, & Gloeckner, 2001). The details of the analyses performed will be discussed in Chapter III.

F. SUMMARY

The Service Selection Process at USNA has been, and continues to be, an evolutionary process. Recently, the Naval Academy has adopted an involved selection process that in many ways mirror job selection processes in the civilian sector. Despite efforts to change the service assignment process at USNA, the Chief of Naval Air Training described current fleet-wide selection standards as "inadequate." Thus, it is reasonable to assume the U.S. Naval Academy will continue to mold its aviation selection process in hopes to best achieve its goal of selecting the "best qualified" candidates for aviation careers.

By observing many different aspects of aviation it is understood that a variety of pilot selection methods exist. Differences exist between commercial aviation and non-commercial aviation, as well as between U.S. military aviation and those among other NATO nations. Surprisingly, differences even exist between U.S. Navy and U.S. Air Force selection methods, although the platforms they are being selected for are closely related. In essence, most commercial pipelines rely on the military to supply experienced pilots, as they too have great difficulties in adequately measuring pilot aptitude from *ab intro* candidates. For this, and many other reasons, the majority of research and development regarding aviation prediction is left up to the U.S. military.

Research suggests that several measures are predictive of aviation success. Amongst these measures are: physical characteristics, psychomotor and mental abilities,

and even several psychological (personality) aspects. In efforts to best quantify these characteristics the U.S. Navy relies heavily on one multi-measure test known as the U.S. Navy and Marine Corps Aviation Selection Test Battery (ASTB).

In an effort to select the best qualified candidates, the U.S. Naval Academy relies on several measures. A service assignment multiple (SAM) is calculated for each candidate. The SAM incorporates ASTB scores and specific measures of academy performance (OOM) and is used in conjunction with personal interview data to finally select candidates for aviation futures. Ultimately, it is believed that this formula does not adequately accommodate all predictive characteristics that are available. In order to examine these phenomena, Bowman's (1998) econometric theory will be applied using SPSS software to the dataset. It is the purpose of the study to examine the selection process from 1995-2002 in order to determine the most predictive characteristics of aviation selection.

III. DATA AND METHODOLOGY

A. INTRODUCTION

From the literature one is able to build several hypotheses. For the purpose of this investigation, a theoretical model of several predictive characteristics of aviation selection at USNA will be developed. The relationship of "pilot selection" at USNA to OOM (and its components), to undergraduate major, to ASTB scores, to family legacy, and to varsity athletics will all be investigated. Theoretically, if the selection process were functioning efficiently, pilot selection should be strongly related to several of these characteristics. The degree to which these characteristics predict group membership between aviators and non-aviators will be examined. The purpose of this chapter is to introduce the data set, discuss the methodology used in the analysis, and to specify a model of aviation selection based on observable characteristics.

B. AVIATION SELECTION

Each of the selected variables included in the model should be important in predicting aviation selection. The following equation depicts a basic linear prediction model:

$$\mathbf{Y_k = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots \beta_n X_n + e_0}$$

The dependent variable "aviation selection" is depicted as $\mathbf{Y_k}$, while the coefficients of each of the independent variables ($\mathbf{X_n}$) are represented by the $\mathbf{\beta_n}$, and e_0 represents a random error term. The independent variables of interest are the two components of OOM -- AQPR and MQPR -- undergraduate major, ASTB scores, family legacy, and varsity athletic participation.

For purposes of this study, the model is estimated for two separate aviation categories. The dependent variable $\mathbf{Y_k}$ represents binary outcome variables that indicate the candidate's career selection, where k=2 outcomes. The first dependent variable, $\mathbf{Y_1}$, distinguishes between "Naval Aviation Selectees," which includes both pilots and NFOs

(labeled NAVYAIR), and all other non-aviation selectees. A second dependent variable, Y_2, will be used to distinguish between "Naval Pilot Selectees," which includes only navy pilots (labeled NPILOT), and all other non-pilot selectees. Notice the second model compares those who select pilot to all others, including those who select naval flight officer as well as those who select non-aviation designators. The two dependent variables will be examined in separate models to investigate the differences in the effects of the explanatory variables in predicting "pilot" selection versus all aviation selection.

C. DATA SOURCE AND SAMPLE

The analysis data set consists of data from two separate sources. The majority of the data were obtained from the Office of Institutional Research at the United States Naval Academy. Additional ASTB scores were supplied by the Naval Aerospace Medical Institute (NOMI) Operational Psychology Department in Pensacola, Florida. The data were merged into a single data set.

The original data set contained 12,484 students and included midshipmen who were currently enrolled as well as those who did not receive a commission. Observations were deleted until only students who graduated and were commissioned within the time frame mentioned above were included. The remaining sample consisted of 7,367 commissioned officers from the U.S. Naval Academy for the years 1995 to 2002. Table 1 displays the observations that were eliminated. The separate ASTB information was available for only 6,214 aviation students. Thus, models that use ASTB data include only 6,214 observations.

Table 1. Sample Observations

	Data Available	
1995-2002 USNA Students	12484	INITIAL SAMPLE
Currently Enrolled	3210	(Removed From Sample)
Attrites from USNA	1814	(Removed From Sample)
Not Physically Qualified	15	(Removed From Sample)
Not Commissioned	68	(Removed From Sample)
International Students	10	(Removed From Sample)
Graduates 1995-2002	**7367**	**FINAL SAMPLE**
OOM Data	7346	
ASTB Data	6214	

All midshipmen failing to graduate or service select from USNA during the selected time period were deleted. Midshipmen who were classified as "currently enrolled" or an "attrite" under the category "Enrollment Status" also were eliminated. Likewise, under category "Commissioning Code," those individuals who were classified as "not commissioned," "not physically qualified," or "did not graduate" were eliminated. Furthermore, international students were removed from the data set since they do not service select into careers in the U.S. Armed Forces. Additionally, data were available for all candidates for all independent variables with the exception of OOM and ASTB (see Table 1). The ASTB is not a mandatory test at USNA and only candidates seeking aviation careers voluntarily take the test. For this reason, ASTB information is not available for all candidates. However, all aviation selectees in the data set had ASTB information.

D. ANALYSIS VARIABLES

1. Aviation Selection Variables

Aviation selection, Pilot or NFO, was determined by the service assignment code, a categorical variable that represents the actual job assignment the student received upon graduation from the Naval Academy. For the present study, service code assignment was

coded as a binary outcome. Two dependent variables were created. The dependent variable (NAVYAIR) was coded =1 for Navy Pilots or NFOs, and coded =0 for all other selection options. Likewise, the second dependent variable (NPILOT) was coded =1 for only Navy Pilots and coded =0 for all other. Table 2 describes the two dependent variables.

Table 2. Descriptive Statistics of Dependent Variables

VARIABLE	CASES (n=)	MISSING	MEAN VALUE	STD DEVIATION
NAVY AIR	7367	0	0.35	0.477
NPILOT	7367	0	0.26	0.437

2. Predictors of Aviation Selection

The data included several types of measures including academic, cognitive, athletic, demographic, and background characteristics. Prior studies suggest that this type of information should be predictive of aviation and pilot success (Pohlman & Fletcher, 1999; Reinhart, 1998; Reis, 2000; Weeks, 2000; Carretta, 2000; and Hedge, Bruskiewicz, Borman, Hansan, & Logan, 2000). From those studies, specific independent (explanatory) variables were selected for inclusion in the prediction model.

For this study, the academic variables included academic quality point ratio (CAQPR), military quality point ratio (CMQPR), and undergraduate major. Additionally, several "family legacy" characteristics were incorporated. These measures included genetic or step-parent military veteran (MIL PAR); prior enlisted midshipmen (PRI ENL); and military preparatory school background (AC PREP). ASTB scores and varsity athletic participation (VARATHL) also were included. ASTB scores were broken down into their sub-tests scores: (AQR, PFAR, FOFAR, PBI, FOBI). Table 3 lists and describes the dependent and independent variables.

Table 3. List of Variables

VARIABLE NAME		DESCRIPTION	
DEPENDENT VARS:			
NAVYAIR		Navy Pilot or NFO:	1=Navy Pilot or NFO Selection; 0=Other
NPILOT		Navy Pilot:	1=Navy Pilot Selection; 0=Other
INDEPENDENT VARS:			
CMQPR		Military QPR: (Scale)	2.0 to 4.0
CAQPR		Academic QPR: (Scale)	2.0 to 4.0
OOM		Order of Merit: (Ordinal)	1 to 1000+
OOMDECR		Order of Merit in Deciles: (Ordinal)	10=Top 10%, 9=Second 10%, 8=Third 10%, 7=Fourth 10%, 6=Fifth 10%, 5=Sixth 10%, 4=Seventh 10%, 3=Eighth 10%, 2=Ninth 10%, 1=Bottom 10%
VARATHL		Varsity Letter Winner:	1=Yes 0=No
MILPAR		Military Parent/Step-Parent:	1=Yes 0=No
PRI ENL		Prior Enlisted Candidate:	1=Yes 0=No
AC PREP		Academic Preparatory School:	1=Yes 0=No
		ASTB Scores: (Scale)	
AQR		Academic Qualifications Ratio:	1.0 to 9.0
PFAR		Pilot Flight Aptitude Rating:	1.0 to 9.0
FOFAR		Flight Officer Aptitude Rating:	1.0 to 9.0
PBI		Pilot Biographical Inventory:	1.0 to 9.0
FOBI		Flight Officer Biographical Inventory:	1.0 to 9.0

Research suggests that undergraduate academic major might also predict aviation and pilot success (Bowman, 1990; Reinhart, 1998; and Reis, 2000). Thus, additional binary variables were created for undergraduate major and graduation year. These variables are listed in Table 4. Each independent variable is described in detail in the following section.

Table 4. Additional Variables

VARIABLE NAME		DESCRIPTION		
MAJ GRP		Major Groups: (Ordinal)	1= Engineering	
			2= Science/Math	
			3= Humanities/Social Science	
		(UNDERGRADUATE MAJOR DUMMY CODE):		
EAS		Aerospace Engineering	1=Major	0=Other
EASA		Aerospace Engineering / Astro	1=Major	0=Other
EEE		Electrical Engineering	1=Major	0=Other
EGE		General Engineering	1=Major	0=Other
EME		Mechanical Engineering	1=Major	0=Other
ENA		Naval Architecture	1=Major	0=Other
EOE		Ocean Engineering	1=Major	0=Other
ESE		Systems Engineering	1=Major	0=Other
ESP		Marine Engineering	1=Major	0=Other
FEC		Economics	1=Major	0=Other
FPS		Political Science	1=Major	0=Other
HEG		English	1=Major	0=Other
HHS		History	1=Major	0=Other
SCH		Chemistry	1=Major	0=Other
SCS		Computer Science	1=Major	0=Other
SGS		General Science	1=Major	0=Other
SMA		Mathematics	1=Major	0=Other
SOC		Oceanography	1=Major	0=Other
SPH		Physics	1=Major	0=Other
SQE		Quantitative Economics	1=Major	0=Other
GRAD_YR		Graduation Year: (Ordinal)	1995-2002	
		(GRAD YR DUMMY CODE):		
GRAD95		1995 Grad:	1=Grad Yr	0=Other
GRAD96		1996 Grad:	1=Grad Yr	0=Other
GRAD97		1997 Grad:	1=Grad Yr	0=Other
GRAD 98		1998 Grad:	1=Grad Yr	0=Other
GRAD99		1999 Grad:	1=Grad Yr	0=Other
GRAD00		2000 Grad:	1=Grad Yr	0=Other
GRAD01		2001 Grad:	1=Grad Yr	0=Other
GRAD02		2002 Grad:	1=Grad Yr	0=Other

3. Description of Predictors of Aviation Selection

a. Military Quality Point Ratio (CMQPR)

CMQPR is a quantitative representation of several variables (physical education, athletic performance, military performance, and military conduct) that are used to measure military performance at the U.S. Naval Academy. It is the same as the variable MQPR found in prior studies, but has been renamed CMQPR to reduce ambiguity in the data set. It is a continuous variable that ranges from 2.00 to 4.00.

b. Academic Quality Point Ratio (CAQPR)

CAQPR is a quantitative representation of a midshipman's cumulative academic grade point average. It is the same as the variable CQPR found in prior studies, but has been renamed CAQPR to reduce ambiguity in the data set. It is a continuous variable that ranges from 2.00 to 4.00.

c. Order of Merit (OOM)

OOM is a combination of the two quantitative measures of military and academic grade point average. It is based on a weight of 65% for academic CQPR and 35% for military MQPR (Larson, 1996). The resulting OOM is used as a measure of overall performance. An OOM=1 represents the highest possible performance. Likewise, OOM is in ascending order and the lowest overall performance is awarded the greatest numerical value. The final data set is missing OOM scores for 21 candidates. Therefore, models that used OOM and OOMDECIL were estimated with only the 7346 valid observations.

d. Order of Merit Deciles (OOMDECR)

OOMDECR represents a recoding of the OOM variable into deciles such that the top performers are in the 10^{th} decile. This variable provides an ordinal representation of OOM. For instance, while the lowest OOM number represents the greatest achievement level, it would fall in the 10^{th} decile. As stated above, 21 cases were missing from this data and were not included in the analyses. Table 5 shows the descriptive characteristics of CMQPR, CAQPR, OOM, and OOM DECR.

Table 5. Descriptive Statistics of Academic Aviation Predictors

VARIABLE	CASES (n=)	MISSING	MEAN VALUE	STD DEVIATION	RANGE
CMQPR	7367	0	3.1743	0.313	2.13-3.99
CAQPR	7367	0	2.9272	0.474	2.0-4.0
OOM	7311	56	465.42	268.784	1-984
OOMDECR	7311	56	5.478	2.864	1-10

e. Varsity Letter Winner (VAR ATH)

VAR ATH represents candidates who have earned one or more varsity letters during their midshipman career. This is a binary variable and does not distinguish between type of sport or numbers of letters earned. Any candidate with one or more earned varsity letter was coded "1" and candidates without varsity letters were coded "0."

f. Military Parent or Step-Parent (MIL PAR)

MIL PAR represents whether the candidate's immediate genetic or step-parents have any military background. This variable is dichotomously coded and does not distinguish between types or lengths of service. Any military history of immediate parents was coded "1" and those without military history were coded "0."

g. Prior Enlisted Midshipmen (PRI ENL)

PRI ENL represents past enlisted military experience of the candidate. This is a binary variable and does not distinguish between service branch or length of service. Any prior enlisted military history was coded "1" and the absence of enlisted military history was coded "0."

h. Academic Preparatory School Background (AC PREP)

AC PREP represents candidates who participated in military preparatory schools (i.e., NAPS, Foundation or Boost), prior to attending USNA. This binary variable does not distinguish between types of military preparatory establishments. Any recorded academic preparatory school participation was coded "1" and was coded "0" otherwise. The frequencies of VARATHL, MILPAR, PRI ENL, AC PREP of "aviation selectees" are depicted in Appendix A. Table 6 shows the descriptive statistics of the variables: VARATHL, MILPAR, PRI ENL, AC PREP.

Table 6. Descriptive Statistics of Additional Aviation Predictors

VARIABLE	CASES (n=)	MISSING	MEAN VALUE	STD DEVIATION	RANGE
VARATHL	7367	0	0.32	0.466	0 - 1
MILPAR	7367	0	0.21	0.404	0 - 1
PRI ENL	7367	0	0.05	0.212	0 - 1
AC PREP	7367	0	0.23	0.423	0 - 1

i. ASTB Scores (AQR, PFAR, FOFAR, PBI, FOBI)

Each ASTB score represents the raw score each candidate received on his or her most recent evaluation. An individual may have taken the test several times. ASTB scores are continuous variables which range from 1.00 to 9.00. Since the ASTB is a voluntary test, not all candidates have corresponding ASTB information. In all, ASTB information was available for 6,214 candidates. Thus, all analyses that used ASTB scores included only 6,214 observations. Additionally, when ASTB scores were introduced into models containing OOM or OOM DECR information, the resulting data set was reduced to 6,173 observations with complete information. Therefore, for logistic models that included both variables, only 6,173 observations were available. Table 7 shows the descriptive statistics of the ASTB components.

Table 7. Descriptive Statistics of ASTB Scores

VARIABLE	CASES (n=)	MISSING	MEAN VALUE	STD DEVIATION	RANGE
AQR	6214	1153	5.61	1.639	1 - 9
PFAR	6214	1153	5.24	1.629	1 - 9
FOFAR	6214	1153	5.5	1.659	1 - 9
PBI	6214	1153	6.59	1.433	1 - 9
FOBI	6214	1153	6.65	1.24	1 - 9

j. Undergraduate Major

Undergraduate Major is the midshipman's field of study. Five independent variables were used to represent major. The first variable, MAJ GRP identifies the academic major group. This variable is an ordinal measure, ranging from 1 to 3, with engineering majors categorized as "GROUP I." Likewise, GROUP II represents mathematic and science majors and GROUP III represents majors in

humanities and social sciences. The frequencies of major groups for "aviation selectees" and "pilot selectees" are depicted in Appendix A.

In addition, a separate dummy variable was created for each of the 18 undergraduate majors. Each dummy variable was labeled with a three-letter identifier for each major. The frequencies of specific undergraduate majors for "aviation selectees" and "pilot selectees" are depicted Appendix A.

k. Graduation year

This study includes eight years of Naval Academy graduates from 1995 to 2002. A binary variable was created for each of the eight years. Table 8 shows the distribution of the sample by graduation year.

Table 8. Descriptive Statistics of Graduation Year

VARIABLE	CASES (n=)	MISSING	MEAN VALUE	STD DEVIATION
1995	895	0	0.12	0.327
1996	937	0	0.13	0.333
1997	943	0	0.13	0.334
1998	908	0	0.12	0.329
1999	877	0	0.12	0.324
2000	933	0	0.13	0.333
2001	913	0	0.12	0.330
2002	961	0	0.13	0.337

E. ASSUMPTIONS

The primary goal of this study was to investigate specific U.S. Naval Academy student predictors of aviation selection for graduates between 1995 and 2002. Research suggests that the components of OOM and ASTB scores will be the focus variables. The additional independent (explanatory) variables controlled for other academic, psychomotor, and demographic factors that also may affect career choice.

The main hypothesis suggests that the characteristics that predict aviation selectees will differ from the characteristics that predict non-aviation selectees. The primary model incorporates a large number of independent variables that research

suggests may be predictive of aviation selection. Research suggests that several characteristics (academic, cognitive, athletic, personality traits) play an important role in predicting success in aviation (Reinhart, 1998; Pohlman & Fletcher, 1999; Carretta, 2000; Hedge, Bruskiewicz, Borman, Hansan, and Logan, 2000; Reis, 2000; and Weeks, 2000). Since research also suggests that not all possible predictive variables were considered adequately by the service assignment process from 1995 to 2002, the primary model expects very few of the included variables to be associated with aviation selection. Therefore, although many of the independent variables may represent predictive characteristics of aviation training success, it is expected that they will not be predictive in the first model of aviation selection.

The secondary model, however, limits the independent variables to a few specific variables based on prior research. This model expects components of OOM and specific ASTB scores to be strongly associated with aviation selection. Research confirms that academic performance might provide several predictors of aviation success. Consequently, additional research suggests that the U.S. Naval Academy may have relied solely on academic OOM and ASTB Scores (Roberge, personal communication, 19 July 2002; Lata, personal communication, 02 October, 2002). Thus, the secondary model expects higher ASTB scores and higher OOM rankings to be strongly predictive of aviation selection.

F. METHODS OF ANALYSIS

The hypotheses are examined in a variety of ways. Before modeling the primary hypothesis and additional research questions, the null hypothesis was investigated. The null hypothesis suggests there are no differences between the characteristics of aviation selectees and non-aviation selectees. To begin this study, preliminary data analyses were conducted on the independent variables to investigate the significance of the null-hypothesis.

The preliminary analyses included descriptive statistics and initial comparisons of all variables. These analyses included frequencies, means, cross-tabs, and T-tests. Following preliminary data testing and the rejection of the null hypothesis, logit models

were estimated. In addition, the empirical results from the logit models were used to calculate marginal effects for each of the independent variables. The marginal effects were then used to explore contingencies of both models to further investigate the behavioral relationships of the independent variables to the selection outcomes.

IV. RESULTS OF MULTIVARIATE MODELS

A. INTRODUCTION

As explained in the preceding chapter, the models used to predict aviation selection at the Naval Academy incorporated several tests. For the purpose of this study, two predictive models of aviation selection at USNA were examined. The models investigated the relationship of "aviation selection" and "pilot selection," respectively, at USNA to OOM (and its components), to undergraduate major, to ASTB scores, to family legacy, and to varsity athletics. Theoretically, if the selection process were functioning as designed, aviation selection should be strongly related to these characteristics. The degree to which these characteristics predict group membership between aviators and non-aviators was examined. The purpose of this chapter is to discuss the preliminary results as well as the overall empirical results of both models.

B. HYPOTHESES AND RESEARCH QUESTIONS

The primary purpose of this thesis was to investigate specific U.S. Naval Academy student characteristics that predict "aviation selection." The main hypothesis suggested the background characteristics that predicted aviation selectees would differ from the characteristics that predicted non-aviation selectees. Two empirical models were used to investigate this hypothesis. The first model incorporated all independent variables, while the second model incorporated specific focus variables that were based on prior research. The second model was expected to be more predictive than the first model. Additionally, the same two models were used to determine whether the predictive factors differ with regard to "pilot selection" as well as "all aviation selection."

Additionally, several related research questions were proposed. Research suggested that several characteristics (academic, cognitive, athletic, personality traits) played an important role in predicting success in aviation (Reinhart, 1998; Pohlman & Fletcher, 1999; Carretta, 2000; Hedge, Bruskiewicz, Borman, Hansan, & Logan, 2000 Reis, 2000; and Weeks, 2000). Therefore, the following secondary research questions also were examined:

- What characteristics (academic, cognitive, athletic, personality traits) are measured at the U.S. Naval Academy?
- Which of those measures are the best predictors of aviation selection?
- What is the quantifiable impact of each measure on aviation service selection?
- Are there differences between Naval Pilots and all Aviation Selectees with regard to the main hypothesis?

Before modeling the hypothesis and additional research questions, the null hypothesis was investigated. The null hypothesis states that there are no differences between the characteristics that predict aviation selectees and those that predict non-aviation selectees. To begin this study, preliminary data analyses were conducted on the independent variables to investigate the null hypothesis.

C. PRELIMINARY DATA ANALYSES

To investigate the null hypothesis, preliminary data analyses included descriptive statistics of the independent variables (CMQPR, CAQPR, OOM, OOMDECILR, VARATHL, MILPAR, PRI ENL, AC PREP, AQR, PFAR, FOFAR, PBI, and FOBI), their collinearity, as well as their relationships to the dependent variable. These preliminary analyses included frequencies, means, cross-tabs, and T-tests. The following sections provide preliminary results for each of the independent variables. For each independent variable, the null hypothesis was investigated for both "aviation selectees" (NAVYAIR) and "pilot selectees" (NPILOT).

1. Selection by Graduation Year

Prior to examining the data set as a whole, a descriptive overview of each graduation year was conducted. It was observed that the availability of Navy Pilot and NFO billets remained relatively constant each year as did the actual selection numbers. Table 9 shows that approximately 35% of each graduating class selected Pilot or NFO and Table 10 shows that about 26% of each class selected Navy Pilot.

Table 9. USNA Graduates Selecting Naval Aviation by Graduating Year

GRAD_YR	NFO or Navy Pilot	Other	Total	Naval Aviators as % of Grads
1995	308	587	895	34%
1996	313	624	937	33%
1997	332	611	943	35%
1998	329	579	908	36%
1999	310	567	877	35%
2000	332	601	933	36%
2001	299	614	913	33%
2002	348	613	961	36%

Table 10. USNA Graduates Selecting Pilot by Graduation Year

GRAD_YR	Navy Pilot	Other	Total	Pilots as % of Grads
1995	209	686	895	23%
1996	232	705	937	25%
1997	243	700	943	26%
1998	250	658	908	28%
1999	231	646	877	26%
2000	232	701	933	25%
2001	241	672	913	26%
2002	258	703	961	27%

The purpose of this study is to examine the hypothesis from 1995 to 2002. Based on initial data results, it was not deemed necessary to investigate the hypotheses for each separate year.

2. Selection by USNA Military Performance

To begin the examination of the null hypothesis, preliminary analyses were performed on the independent variables representing academic and military performance. Differences in means of CMQPR, CAQPR, OOM and OOM DECR were examined using independent sample T-tests. For each independent variable, the null hypothesis was examined for both "aviation selectees" (NAVYAIR) and "pilot selectees" (NPILOT). Table 11 displays the results of the independent T-tests for differences in academic and

military performance for all "aviation" versus "non-aviation" selectees, while Table 12 conducts the same test for the "pilot" and "non-pilot" groups.

Table 11. T-Test of Differences in Academic and Military Performance for Aviation Selectees and Non-Aviation Selectees

Academic Measure	Aviation Mean	Non-Aviation Mean	Difference	T-Stat*	Significance
CMQPR	3.2085	3.158	0.0504	-6.619	<.001
CAQPR	2.9739	2.9051	0.0688	-5.953	<.001
OOM	434.87	478.4	43.54	6.605	<.001
OOM DECR	5.7906	5.3436	0.447	-6.37	<.001

Note: T-Test Assumes Equal Variances

Table 12. T-Test of Differences in Academic and Military Performance for Pilot Selectees and Non-Pilot Selectees

Academic Measure	Pilot Mean	Non-Pilot Mean	Difference	T-Stat*	Significance
CMQPR	3.2226	3.1594	0.0632	-7.616	<.001
CAQPR	2.9924	2.9072	0.0852	-6.769	<.001
OOM	421.12	477.8	56.68	7.897	<.001
OOM DECR	5.9339	5.349	0.5849	-7.654	<.001

Note: T-Test Assumes Equal Variances

As shown in the above tables, the means of the academic and military performance variables were significantly different between all aviator and non-aviators (Table 12) and between pilots and non-pilots (Table 13). Thus, the null hypothesis can be rejected for the academic and performance variables above.

The results show that both "aviation selectees" and "pilot selectees" have higher mean CMQPRs and CAQPRs than non-selectees. Furthermore, the results show that both "aviation" and "pilot" selectees have lower average OOMs and higher OOM DECRs than non-selectees. Remembering that a lower number OOM related to a higher grade point average and a higher OOM DECR, the data suggests that aviation and pilot selectees achieve higher average levels of military and academic performance at the Naval Academy, as compared to those choosing other communities. It is important to note that OOM is highly correlated with its components (CMQPR and CAQPR).

Therefore, further empirical analysis did not incorporate both OOM and any of its components in the regression models.

3. Selection by Background Characteristics

To further examine the null hypothesis, preliminary analyses of VARATHL, MILPAR, PRI ENL, and AC PREP were conducted. These independent variables represent personal background characteristics of each candidate. For each independent variable the null hypothesis was examined for both "aviation selectees" (NAVYAIR) and "pilot selectees" (NPILOT). Table 13 displays the results of the independent T-tests for the differences in the background characteristics of "aviation" versus "non-aviation" selectees, while Table 14 compares "pilots" and "non-pilots.

Table 13. T-Test of Differences in Background Characteristics for Aviation Selectees and Non-Aviation Selectees

Personality Trait	Aviation Mean	Non-Aviation Mean	Difference	T-Stat*	Significance
VARATHL	0.31	0.32	0.02	1.579	0.001
MILPAR	0.22	0.2	0.03	-2.656	0.008
PRI ENL	0.04	0.05	0.01	2.094	0.036
AC PREP	0.2	0.25	0.06	5.543	<.001

Note: T-Test Assumes Equal Variances

Table 14. T-Test of Differences in Background Characteristics for Pilot Selectees and Non-Pilot Selectees

Personality Trait	Aviation Mean	Non-Aviation Mean	Difference	T-Stat*	Significance
VARATHL	0.31	0.32	0.02	1.366	0.172
MILPAR	0.22	0.2	0.02	-1.678	0.093
PRI ENL	0.04	0.05	0.01	1.838	0.066
AC PREP	0.19	0.25	0.05	4.612	<.001

Note: T-Test Assumes Equal Variances

As shown in the above tables, the means of the background variables were statistically significant for NAVYAIR (Table 13) but only marginally significant for NPILOT (Table 14). Thus, the null hypothesis can be rejected for the personal characteristic variables as related to "aviation selectees" (NAVYAIR). In reviewing the results for "pilot selectees"

(NPILOT), it can be noted that all variables except VARATHL were marginally statistically significant at the 0.10 level. Although these results are not as significant as for NAVYAIR, it may still be concluded that there are differences in background characteristics between "pilot selectees" and "non-pilot selectees."

Additionally, these results suggest that, on average, "aviation selectees" and "pilot selectees" have a higher percentage of military parents (MIL PAR) as compared to other non-selectees. Conversely, it also suggest that non-selectees, on average, have a higher percentage of varsity athletes (VARATHL), prior enlisted candidates (PRI ENL), as well as a higher percentage of candidates who participated in academic preparatory programs (AC PREP).

4. Selection by Undergraduate Major

Initial data results suggested possible relationships between specific academic criteria and aviation service selection. Undergraduate majors were examined in two manners. First, frequencies of all possible undergraduate major fields were examined for both "aviation selectees" (NAVYAIR) and "navy pilots" (NPILOT). The frequencies of specific undergraduate majors for "aviation selectees" and "pilot selectees" are shown Appendix A.

Further analysis was done on undergraduate majors by examining the three major groups (MAJ GRP). The means of GROUP I, GROUP II, and GROUP III were examined using frequency analysis and independent sample T-tests. The frequencies of major groups for "aviation selectees" and "pilot selectees" are shown in Appendix A. Additionally, the T-test differences in means are depicted in Table 15 and Table 16. For each independent variable, the null hypothesis was examined for both "aviation selectees" (NAVYAIR) and "pilot selectees" (NPILOT).

Table 15. T-Test Differences in Major Groups for Aviation Selectees and Non-Aviation Selectees

Major Group	Aviation Mean	Non-Aviation Mean	Difference	T-Stat*	Significance
GROUP I	0.4154	0.3511	0.0643	-5.437	<.001
GROUP II	0.2223	0.2530	0.0307	2.931	0.003
GROUP III	0.3623	0.3959	0.0335	2.818	0.005

Note: T-Test Assumes Equal Variances

Table 16. T-Test Differences in Major Groups for Pilot Selectees and Non-Pilot Selectees

Major Group	Pilot Mean	Non-Pilot Mean	Difference	T-Stat*	Significance
GROUP I	0.4204	0.3573	0.0631	-4.897	<.001
GROUP II	0.2253	0.2482	0.0229	2.006	0.045
GROUP III	0.3543	0.3945	0.0402	3.098	0.002

Note: T-Test Assumes Equal Variances

As shown in Table 15 and 16, the differences in group major variables were statistically significant to the 0.05 level for both NAVYAIR (Table 15) and NPILOT (Table 16). Thus, the null hypothesis can be rejected for the major group variables above. The T-tests showed that both "aviation selectees" and "pilot selectees" had a higher percentage of GROUP I (technical) majors as compared to non-selectees and a lower percentage of GROUP II (math and science) and GROUP III (humanities and social science) majors.

5. Selection by ASTB Scores

The final preliminary analysis was conducted on ASTB scores. The means of AQR, PFAR, FOFAR, PBI, and FOBI, were examined using independent sample T-tests. For each independent variable, the null hypothesis was investigated for both "aviation selectees" (NAVYAIR) and "pilot selectees" (NPILOT). Table 17 displays the results of the independent T-tests for the differences in the ASTB scores of "aviation" versus "non-aviation" selectees, while Table 18 compares "pilots" and "non-pilot" selectees.

Table 17. T-Test of Differences in ASTB Scores for Aviation Selectees and Non-Aviation Selectees

ASTB Scores	Aviation Mean	Non-Aviation Mean	Difference	T-Stat*	Significance
AQR	5.98	5.36	0.62	-14.868	<.001
PFAR	5.68	4.94	0.74	-18.033	<.001
FOFAR	5.88	5.24	0.65	-15.388	<.001
PBI	6.88	6.38	0.50	-13.833	<.001
FOBI	6.86	6.51	0.35	-11.123	<.001

Note: T-Test Assumes Equal Variances

Table 18. T-Test of Differences in ASTB Scores for Pilot Selectees and Non-Pilot Selectees

ASTB Scores	Pilot Mean	Non-Pilot Mean	Difference	T-Stat*	Significance
AQR	6.03	5.43	0.60	-13.425	<.001
PFAR	5.74	5.02	0.72	-16.262	<.001
FOFAR	5.93	5.32	0.61	-13.482	<.001
PBI	6.93	6.44	0.49	-12.552	<.001
FOBI	6.86	6.56	0.30	-8.737	<.001

Note: T-Test Assumes Equal Variances

As shown in the above tables, the mean differences of all ASTB scores were statistically significant for both NAVYAIR (Table 17) and NPILOT (Table 18). Thus, the null hypothesis can be rejected for the ASTB score variables above. The results show that the average ASTB scores of "aviation selectees" and "pilot selectees" were higher than average scores for non-selectees.

D. EMPIRICAL MODEL RESULTS

The results of the preliminary data analysis rejected the null hypothesis of equality of means of background characteristics of "aviation selectees" (NAVYAIR) and "pilot selectees" (NPILOT) versus non-aviation or non-pilot selectees. Based on these results the null hypothesis can be rejected and it may be concluded that there are differences between aviation selectees and non-aviation selectees with respect to the background characteristic variables.

Following preliminary data testing, two logistic regression models were used to further examine the original hypothesis. The estimated coefficients from each model were used to calculate marginal effects for each of the independent variables.

1. Primary Model

The main hypothesis suggests there are characteristics that predict aviation selectees that differ from the characteristics that predict non-aviation selectees. Two empirical models were used to investigate this hypothesis. The primary model incorporated all independent variables (CMQPR, CAQPR, OOM, OOMDECILR, VARATHL, MILPAR, PRI ENL, AC PREP, AQR, PFAR, FOFAR, PBI, and FOBI).

The primary multivariate models estimated were as follows:

> NAVYAIR or NPILOT = *f* (Military Performance Grade Point Average, Academic Performance Grade Point Average, Varsity Athletic Participation, Military Parent Relation, Prior Enlisted Status, Academic Preparatory School Attendance, ASTB Score Performance).

The following section discusses the results of estimating the primary multivariate model. This model was used to explore the main hypothesis with regard to both "aviation selectees" (NAVYAIR) and "pilot selectees" (NPILOT).

2. Primary Model Results (NAVYAIR)

This model quantifies the effects of each independent variable on both "aviation selectees" (NAVYAIR) and "pilot selectees" (NPILOT) for the 1995 to 2002 period. Recalling that the ASTB is a voluntary test and not all candidates have corresponding ASTB information, the estimation sample included 6,173 candidates with the necessary information. For the categorical variables, VARATHL, PRI ENL, AC PREP, and MIL PAR, the omitted case is the absence of these personal traits. Likewise for the categorical variables representing undergraduate major group, the omitted case is Group III (Humanities and Social Science) majors.

Table 19 displays the results of the primary model estimates for "aviation selectees" (NAVYAIR). The table includes the estimated coefficients (β), marginal effects, standard errors, and significance levels. The marginal effects indicate the effect

of each independent variable on the probability of being selected for "aviation" (in Table 19) or being selected for "pilot" (in Table 20).

Table 19. Primary Model Results for All Aviation Selectees

Variable	β	Marginal Effects	S. E.	Sig.
Constant	-3.449	-0.703	0.325	0.000
CMQPR	-0.084	-0.017	0.124	0.498
CAQPR	**0.198**	**0.040**	**0.085**	**0.020**
VAR ATHL	0.047	0.010	0.060	0.438
MIL PAR	**0.177**	**0.036**	**0.066**	**0.007**
PRI ENL	**-0.294**	**-0.060**	**0.133**	**0.027**
AC PREP	-0.126	-0.026	0.070	0.073
MAJ GRP 3 (Reference)				
MAJ GRP 1	**-0.150**	**-0.031**	**0.067**	**0.024**
MAJ GRP 2	**-0.165**	**-0.034**	**0.072**	**0.021**
AQR	-0.071	-0.014	0.043	0.100
PFAR	**0.299**	**0.061**	**0.037**	**0.000**
FOFAR	0.007	0.001	0.043	0.868
PBI	**0.156**	**0.032**	**0.023**	**0.000**
FOBI	**0.090**	**0.018**	**0.026**	**0.000**
n = 6173 Chi-Square: 444.106		-2 Log Likelihood: 7923.914 Nagelkerke R^2: 0.094		

a. Bold highlighted independent variables and corresponding values denote statistical significance to at least the .050 level.
b. Marginal effects were evaluated at mean levels of all independent variables.

a. Academic and Military Performance Measures

Of the academic and military performance measures included in the model, only CAQPR was statistically significant ($P < 0.05$). The results show that increasing a candidate's CAQPR by one unit (1.0) resulted in an increased likelihood of selection of 4 percent. Since CAQPR varies from 1.0 to 4.0, the effect of a fairly large change in CAQPR on the selection probability is, in practical terms, quite small.

b. Background Characteristics

Of the background variables in the model, MIL PAR and PRI ENL were statistically significant. The model suggests that being prior enlisted actually decreased one's likelihood of aviation selection by 6 percent, whereas having a military parent increased selection probability by 3.6 percent.

c. Undergraduate Majors

Of the undergraduate major variables, both GROUP I and GROUP II majors were significant and negative compared to GROUP III. Candidates with an undergraduate degree in either Engineering (GROUP I) or Mathematics and Science (GROUP II) were about 3 percent less likely to be selected as "aviation selectees" as compared to those studying in Humanities and Social Science. While Reis (2000) found that aviators with engineering degrees had a greater propensity for flight school completion than other technical or non-technical counterparts, these results suggest that candidates at USNA with non-technical degrees had a higher chance of being selected as aviators. Suprisingly, folklore at the Academy suggests that one should avoid technical majors as an undergraduate if it is their desire to pursue aviation careers. According to these results, this "Poly-Sci and Fly" mentality was confirmed by the selection process from 1995 to 2002.

d. ASTB Scores

Three of the five ASTB score variables in the model (PFAR, PBI, and FOBI) were statistically significant. PFAR (which is designed to be a predictor of "pilot" performance as compared to all "aviators") had one of the largest marginal effects of any explanatory variable. An increase of one point in the PFAR section (which ranges between 1 and 9) of the ASTB increased the probability of aviation selection by 6.1 percent. By comparison, an increase in the PBI section (range 1 to 9) increased the probability of selection by 3.2 percent (or one-half) and an increase in FOBI (range 1 to 9) increased the probability by 1.8 percent (less than one-third).

3. Primary Model Results (NPILOT)

Table 20 displays the results of estimating the model just for "pilot selectees." The table includes the estimated logit coefficients (β), marginal effects, standard errors, and significance levels. Recall that the comparison group includes all non-pilot selectees in the sample and includes NFO's as well as other non-aviation selectees.

The main difference between Table 19 and Table 20 is that whereas eight variables were statistically significant ($P \leq 0.05$) for predicting "all aviation" selectees,

only four are significant in the "pilot" selection model. However, three additional variables were marginally significant ($P \leq 0.10$) in Table 20.

Table 20. Primary Model Results for Pilot Selectees

Variable	β	Marginal Effects	S. E.	Sig.
Constant	-4.321	-0.734	0.350	0.000
CMQPR	0.087	0.015	0.132	0.509
CAQPR	**0.247**	**0.042**	**0.090**	**0.006**
VAR ATHL	0.012	0.002	0.064	0.855
MIL PAR	0.125	0.021	0.070	0.076
PRI ENL	**-0.284**	**-0.048**	**0.144**	**0.049**
AC PREP	-0.086	-0.015	0.076	0.259
MAJ GRP 3 (Reference)				
MAJ GRP 1	-0.131	-0.022	0.071	0.066
MAJ GRP 2	-0.107	-0.018	0.077	0.163
AQR	-0.060	-0.010	0.046	0.194
PFAR	**0.310**	**0.053**	**0.039**	**0.000**
FOFAR	-0.037	-0.006	0.045	0.419
PBI	**0.170**	**0.029**	**0.025**	**0.000**
FOBI	0.046	0.008	0.027	0.092
n = 6173 Chi-Square: 362.599		-2 Log Likelihood: 7217.867 Nagelkerke R^2: 0.081		

a. Bold highlighted independent variables and corresponding values denote statistical significance to at least the .050 level.
b. Marginal effects were evaluated at mean levels of all independent variables.

a. Academic and Military Performance Measures

Of the academic and military performance measures included in the model, CAQPR was again statistically significant ($P < 0.05$). Similar to the aviation model, the results show that increasing a candidate's CAQPR by one unit (1.0) increased the likelihood of pilot selection of 4.2 percent. Again, the practical impact of this variable is fairly small.

b. Background Characteristics

Of the background variables in the model, only PRI ENL was statistically significant at the $P \leq 0.05$ level. The model results suggest that being prior enlisted decreased one's likelihood of pilot selection by 4.8 percent. The MIL PAR was

marginally significant at the $P \leq 0.10$ level and suggested that candidates with military parents had a higher probability of selection.

c. Undergraduate Majors

Of the undergraduate major variables in the model, no group was statistically significant as compared to the reference. However, the coefficients of both GROUP I and GROUP II majors were negative and GROUP I was marginally significant at the 0.066 level.

d. ASTB Scores

Of the ASTB score variables in the model, PFAR and PBI were statistically significant. Once again, PFAR which is designed to be a predictor of "pilot" performance as compared to all "aviators," had the largest marginal effect (5.3 percent) in the model. An increase of one point in the PBI increased the probability of selection by 2.9 percent.

4. Primary Model Contingency Results

In addition to these results, further information was gained from modeling predicted probability effects via contingency models. Three candidate types were used to investigate the behavioral relationships of each explanatory variable on the selection probability. The first candidate type (LOWER), represents a candidate with the minimal academic achievement levels and with background characteristics coded as 0.[1] The second type (AVERAGE), represents the average candidate in the sample. The final type (PERFECT), represents a candidate with the highest academic achievement levels and all background characteristics coded as 1. Table 21 displays the predicted probability scores for "all aviation" selectees, while Table 22 displays the same information for "pilot" selectees. Furthermore, Figure 1 depicts the predicted probability for both "all aviation" and "pilots." All marginal effects used to produce the contingency models are shown in Appendix C.

[1] When coded as 0, the background characteristics represent a candidate who is not prior enlisted, not a varsity athlete, not from an academic prep-school, and does not have a military parent.

Table 21. Primary Model Contingencies for All Aviation Selectees

	CANDIDATE TYPE		
VARIABLE NAME	LOWER	AVERAGE	PERFECT
CMQPR	2.00	3.18	4.00
CAQPR	2.00	2.94	4.00
VAR ATHL	0.00	0.30	1.00
MIL PAR	0.00	0.22	1.00
PRI ENL	0.00	0.05	1.00
AC PREP	0.00	0.22	1.00
MAJ GRP 1	0.00	1.99	1.00
MAJ GRP 2	0.00	1.99	0.00
AQR	1.00	5.62	9.00
PFAR	1.00	5.24	9.00
FOFAR	1.00	5.50	9.00
PBI	1.00	6.58	9.00
FOBI	1.00	6.65	9.00

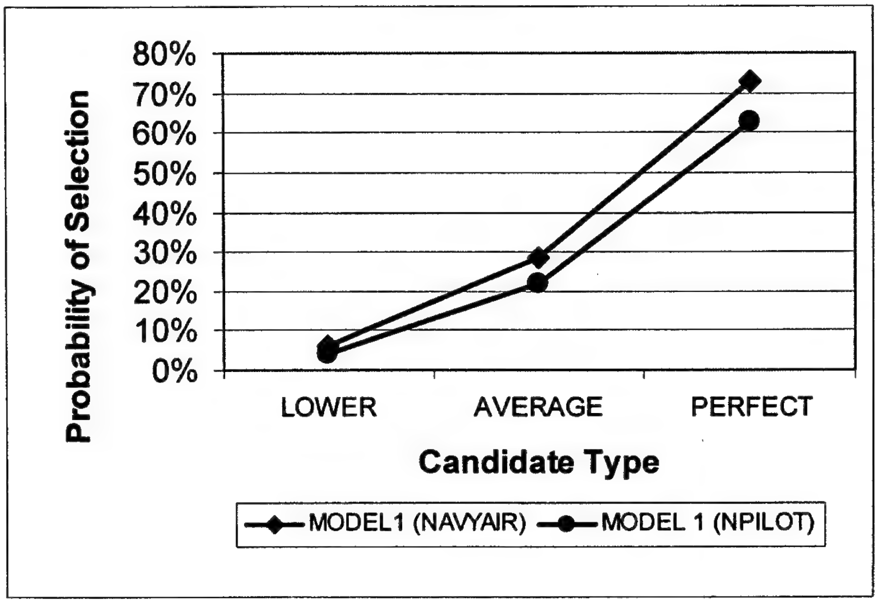
Probability of Selection	LOWER	AVERAGE	PERFECT
	6.07%	28.51%	72.91%

Table 22. Primary Model Contingencies for Pilot Selectees

	CANDIDATE TYPE		
VARIABLE NAME	LOWER	AVERAGE	PERFECT
CMQPR	2.00	3.18	4.00
CAQPR	2.00	2.94	4.00
VAR ATHL	0.00	0.30	1.00
MIL PAR	0.00	0.22	1.00
PRI ENL	0.00	0.05	1.00
AC PREP	0.00	0.22	1.00
MAJ GRP 1	0.00	1.99	1.00
MAJ GRP 2	0.00	1.99	0.00
AQR	1.00	5.61	9.00
PFAR	1.00	5.24	9.00
FOFAR	1.00	5.50	9.00
PBI	1.00	6.59	9.00
FOBI	1.00	6.65	9.00

Probability of Selection	LOWER	AVERAGE	PERFECT
	3.83%	21.69%	62.53%

Figure 1. Comparison of Primary Model Contingencies between All Aviation and Pilot Selectees



As shown in Figure 1, the probability of being selected for "all aviation" and "pilot" improved significantly, in the primary model, with dramatic improvement in academic performance and background characteristics from "lower" to "perfect." From the contingency model, a candidate's probability of "aviation" selection improved from 6.07% to 72.91% (as seen in Table 21). Also, a candidate's probability of "pilot" selection improved from 3.83% to 62.53% (as seen in Table 22). Lastly, the primary model suggested that the "average" candidate's probability of being selected for "aviation" (NAVYAIR) from 1995 to 2002 was 28.5% (see Table 21). Likewise, the probability of being selected for "pilot" (NPILOT), for the "average" candidate, during that time was 21.7% (Table 22).

5. Secondary Model

The secondary model includes two categories of variables. The secondary model expects the individual components of OOM and ASTB scores to be strongly predictive of aviation selection. Although research suggests that academic background should predict

aviation training success (Bowman, 1990; Gremillion, 1998; Reinhart, 1998; and Reis, 2000), further research suggests that in recent history the U.S. Naval Academy selection procedures have almost solely relied on academic OOM and ASTB Scores (Roberge, personal communication, 19 July 2002; Lata, personal communication, 02 October, 2002). Thus the secondary model expects higher ASTB scores and higher OOM rankings to be more predictive of aviation selection.

The secondary multivariate models were estimated as follows:

NAVYAIR or NPILOT = f (Military Performance Grade Point Average, Academic Performance Grade Point Average, ASTB Score Performance).

The following section discusses the results of the secondary logistic regression model. As in the first model, marginal effects of each independent variable are also presented.

6. Secondary Model Results (NAVYAIR)

Like the primary model, the sample included 6173 candidates with all corresponding information. Table 23 displays the results for "all aviation selectees" (NAVYAIR).

Table 23. Secondary Model Results for All Aviation Selectees

Variable	β	Marginal Effects	S. E.	Sig.
Constant	-3.458	-0.835	0.311	0.000
CMQPR	-0.108	-0.026	0.121	0.371
CAQPR	**0.239**	**0.058**	**0.083**	**0.004**
AQR	**-0.098**	**-0.024**	**0.042**	**0.020**
PFAR	**0.298**	**0.072**	**0.037**	**0.000**
FOFAR	0.021	0.005	0.042	0.615
PBI	**0.153**	**0.037**	**0.023**	**0.000**
FOBI	**0.089**	**0.021**	**0.025**	**0.000**
n = 6173 Chi-Square: 421.098		-2 Log Likelihood: 7946.923 Nagelkerke R^2: 0.089		

a. Bold highlighted independent variables and corresponding values denote statistical significance to at least the .050 level.

b. Marginal effects were evaluated at mean levels of all independent variables.

a. Academic and Military Performance Measures

Of the academic and military performance measures included in the model, only CAQPR was statistically significant ($P < 0.05$). Increasing a candidate's CAQPR one unit (1.0) resulted in an increased likelihood of aviation selection by 5.8 percent. The impact of CAQPR is somewhat larger than in the first model.

b. ASTB Scores

Of the ASTB score variables in the model, all scores were statistically significant with the exception of FOFAR. Once again, PFAR had the largest marginal effect in the model. An increase of one point in the PFAR section of the ASTB increased the likelihood of aviation selection by 7.2 percent. A surprising result was, this model found that increasing one's AQR score reduced the likelihood of aviation selection.

7. Secondary Model Results (NPILOT)

Table 24 displays the results of the secondary model for "pilot selectees" (NPILOT). Again there are fewer significant variables (3) than in the "all aviation" model(s). However, two variables are marginally significant at the 0.10 level.

Table 24. Secondary Model Results for Pilot Selectees

Variable	β	Marginal Effects	S. E.	Sig.
Constant	-4.298	-0.888	0.336	0.000
CMQPR	0.057	0.012	0.129	0.659
CAQPR	**0.280**	**0.058**	**0.088**	**0.001**
AQR	-0.082	-0.017	0.045	0.067
PFAR	**0.310**	**0.064**	**0.039**	**0.000**
FOFAR	-0.026	-0.005	0.045	0.566
PBI	**0.165**	**0.034**	**0.024**	**0.000**
FOBI	0.045	0.009	0.027	0.096
n = 6173 Chi-Square: 350.517		-2 Log Likelihood: 7229.948 Nagelkerke R^2: 0.078		

a. Bold Highlighted independent variables and corresponding values denote statistical significance to at least the .050 level.

b. Marginal effects were evaluated at mean levels of all independent variables.

a. Academic and Military Performance Measures

Of the academic and military performance measures included in the model, once again CAQPR was statistically significant ($P < 0.05$). Increasing a candidate's CAQPR one unit (one point) resulted in an increased likelihood of pilot selection by 5.8 percent.

b. ASTB Scores

Of the ASTB score variables in the model, only PFAR and PBI were statistically significant. Once again, PFAR had the largest effect in the model. An increase of one point in the PFAR section of the ASTB increased the likelihood of aviation selection by 6.4 percent. Additionally, an increase in PBI increased the probability of selection by 3.4 percent.

8. Secondary Model Contingency Results

As in the primary model, contingency models were again used to further model the predicted probability. The same three candidate types were constructed to investigate the behavioral relationships between background characteristics and aviation selection. Table 25 displays the predicted probability for "all aviation" selectees, while Table 26 displays the same information for "pilot" selectees. Furthermore, Figure 2 depicts the predicted probability of the primary model for both "all aviation" and "pilots."

Table 25. Secondary Model Contingencies for All Aviation Selectees

	CANDIDATE TYPE		
VARIABLE NAME	LOWER	AVERAGE	PERFECT
CMQPR	2.00	3.18	4.00
CAQPR	2.00	2.94	4.00
AQR	1.00	5.61	9.00
PFAR	1.00	5.24	9.00
FOFAR	1.00	5.50	9.00
PBI	1.00	6.59	9.00
FOBI	1.00	6.65	9.00

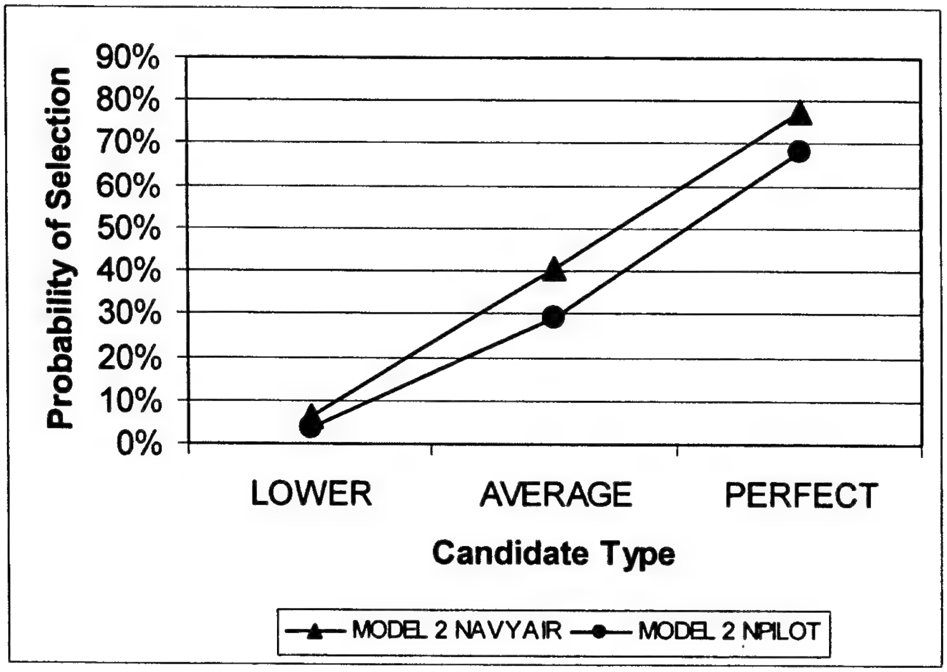
Probability of Selection	LOWER	AVERAGE	PERFECT
	6.11%	40.80%	77.43%

Table 26. Secondary Model Contingencies for Pilot Selectees

	CANDIDATE TYPE		
VARIABLE NAME	LOWER	AVERAGE	PERFECT
CMQPR	2.00	3.18	4.00
CAQPR	2.00	2.94	4.00
AQR	1.00	5.61	9.00
PFAR	1.00	5.24	9.00
FOFAR	1.00	5.50	9.00
PBI	1.00	6.59	9.00
FOBI	1.00	6.65	9.00

Probability of Selection	LOWER	AVERAGE	PERFECT
	3.87%	29.19%	68.09%

Figure 2. Comparison of Secondary Model Contingencies between All Aviation and Pilot Selectees



As shown in Figure 2, the probability of being selected for "all aviation" and "pilot" improved significantly, in the secondary model, when the background characteristics changed from "lower" to "perfect." From the contingency model, a candidate's probability of "aviation" selection rose from 6.11% to 77.43% (as seen in Table 25). Also, a candidate's probability of "pilot" selection rose from 3.87% to 68.09% (as seen in Table 26). Lastly, the secondary model suggested that the "average" candidate's probability of being selected for "aviation" (NAVYAIR) from 1995 to 2002 was 40.8% (see Table 25). Likewise, the "average" candidate's probability of being selected for "pilot" (NPILOT) during that time was 29.19% (Table 26). All marginal effects used to construct the contingency models are shown in Appendix C.

E. SUMMARY OF RESULTS

The preliminary data analysis results suggested several things. The comparisons of characteristics between "aviation selectees" (NAVY AIR) and non-selectees and

between "pilot selectees" (NPILOT) and non-selectees, showed significant differences in group means. "Aviation selectees" and "pilot selectees" displayed higher mean CMQPRs and CAQPRs than non-selectees, as well as lower average OOMs and higher OOM DECRs than non-selectees. Therefore, the data suggests that aviation and pilot selectees achieve higher military and academic performance at the US Naval Academy, as compared to those selecting other career choices. Likewise, for all ASTB scores both "aviation selectees" and "pilot selectees" achieved higher average scores than non-selectees.

Furthermore, "aviation selectees" and "pilot selectees" had a higher percentage of military parents (MIL PAR) as compared to other non-selectees. Surprisingly, results also suggest that non-selectees, on average, have a higher percentage of varsity athletes (VARATHL), prior enlisted candidates (PRI ENL), as well as a higher percentage of participants in academic preparatory programs (AC PREP). In addition, both "aviation selectees" and "pilot selectees" had a higher percentage of GROUP I majors as compared to non-selectees. In another interesting contrast, results also showed that non-selectees have a higher percentage of both GROUP II and GROUP III majors as compared to aviation and pilot selectees.

The results from the primary multivariate models suggest several characteristics predicted selection. For "aviation selection" (NAVYAIR), CAQPR, MIL PAR, PFAR, PBI, and FOBI were all positive predictors of selection, while PRI ENL, MAJ GRP 1, and MAJ GRP 2 decreased one's likelihood of selection (see Table 19). In addition, for "pilot selectees" (NPILOT), CAQPR, PFAR, and PBI were all positive predictive measures of selection, while PRI ENL once again decreased one's likelihood of selection (see Table 20).

The secondary model found that several of the above mentioned variables had a greater impact on selection. For "aviation selection" (NAVYAIR), CAQPR, PFAR, PBI, and FOBI were all positive predictive measures of selection, while surprisingly AQR actually decreased one's likelihood (see Table 21). In addition, for "pilot selectees" (NPILOT), CAQPR, PFAR, and PBI were all positive predictive measures of selection, while no variables displayed a significant negative impact on selection (see Table 22).

Finally, the contingency model results provided additional insightful information. The independent variables in the secondary model displayed a larger impact on predicted probability for both "aviation selection" and "pilot selection," as compared to the primary model. Using the secondary model, the predicted probability, on average, of being selected for "aviation" (NAVYAIR) was 40.8% (see Table 25). Likewise, the probability of being selected for "pilot" (NPILOT) was 29.19% (see Table 26). It is most noteworthy that the same two variables (PFAR and CAQPR) displayed the greatest overall impact on "aviation" and "pilot" selection in both models.

V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

A. SUMMARY

The primary purpose of this thesis was to investigate specific U.S. Naval Academy student predictors of "aviation selection." Research suggested that several characteristics (academic, cognitive, athletic, and background characteristics are important predictors of success in aviation (Reinhart, 1998; Pohlman & Fletcher, 1999; Carretta, 2000; Hedge, Bruskiewicz, Borman, Hansan, & Logan, 2000; Reis, 2000; and Weeks, 2000). Therefore, the main hypothesis identified characteristics that predict aviation selectees and that differed from those characteristics that predict non-aviation selectees.

1. Background Characteristics

While examining our original hypothesis several additional questions were examined. The first question was: "What characteristics (academic, cognitive, athletic, demographic) are measured at the U.S. Naval Academy?" Based on research, specific measured characteristics were identified, used as independent variables, and found to be strongly related to aviation selection at USNA.

Reis's (2000) and Reinhart's (1998) studies both suggested that undergraduate education and level of academic performance were significant predictors of aviation performance. This study reinforced these results and found that "all aviation selectees" and "pilot selectees" possessed higher mean CMQPRs and CAQPRs than non-selectees, as well as lower average OOMs and higher OOM DECRs than non-selectees. Therefore, the data suggests that aviation and pilot selectees are characterized by higher average levels of military and academic performance at the US Naval Academy, as compared to those who make other career choices. Additionally, both "aviation selectees" and "pilot selectees" achieved higher average scores on all ASTB tests than non-selectees. Furthermore, the estimated marginal effects in both models found that CAQPR and specific ASTB scores had sizable effects on selection for "all aviation" and "pilots."

In relation to undergraduate academic performance, another interesting result was the impact of undergraduate academic majors. Results showed that from 1995 to 2002,

both "aviation selectees" and "pilot selectees" had a higher percentage of GROUP I majors as compared to non-selectees. Conversely, non-selectees had a higher percentage of GROUP II and GROUP III majors as compared to aviation and pilot selectees.

Specific background characteristics also were found to be significant. Prior research suggested that these measures would include "physical, psychomotor and mental ability, and psychological (personality) requirements" (Pohlman and Fletcher, 1999, p. 284). Most importantly, prior research suggested that flight training success relied heavily on measurable psychomotor skills (Hunter, 1989; English, 1992; Pohlman & Fletcher, 1999; Reinhart, 1998; Reis, 2000; Weeks, 2000; Carretta, 2000; Hedge, Bruskiewicz, Borman, Hansan, & Logan, 2000). Unfortunately, other than varsity athletic participation and Physical Readiness Test (PRT) scores, the U.S. Naval Academy does not maintain data on many physical or psychomotor characteristics. In this study, results suggested aviation and pilot selectees had a lower percentage, on average, of varsity athletes as compared to non-selectees.

2. Best Predictors of Aviation Selection

Another secondary research question was: "Which of the available measures are the best predictors of aviation selection" and "what is the quantifiable impact of each measure on aviation service selection?" Two empirical models were used to investigate this aspect of the hypothesis. The primary model incorporated all independent variables, while the second model incorporated specific research-based "focus variables."

The results of the primary model suggest several characteristics had a significant impact on selection. For "aviation selection" (NAVYAIR), CAQPR, MIL PAR, PFAR, PBI, and FOBI were all positive predictive measures of selection, while PRI ENL, GROUP I, and GROUP II actually decreased one's likelihood (Table 19). In addition, for "pilot selectees" (NPILOT), CAQPR, PFAR, and PBI were all positive predictive measures of selection, while PRI ENL once again decreased one's likelihood of selection (Table 20).

Likewise, the results of the secondary model suggest that several of the above mentioned variables had a significant impact on selection. For "aviation selection" (NAVYAIR), CAQPR, PFAR, PBI, and FOBI were all positive predictors of selection,

while surprisingly AQR decreased one's likelihood (Table 21). In addition, for "pilot selectees" (NPILOT), CAQPR, PFAR, and PBI were all positive predictive measures of selection.

PFAR, which is designed to be a predictor of "pilot" performance as compared to all "aviators," had the largest marginal effect of any explanatory variable. CAQPR had the second largest impact. These results were representative of both "aviation" and "pilot selection." Surprisingly, prior enlisted status displayed the highest negative impact in the primary model for "aviators" and "pilots" alike. There is no research to suggest that the selection process adversely targeted prior enlisted personnel, yet the results of this study suggest that prior enlisted personnel had a significantly lower likelihood of selecting aviation careers.

3. Differences Between Aviation and Pilot Selection

The final question asked was: "Are there differences between Naval Pilots and all Aviation Selectees with regard to the main hypothesis?" The thesis compared each category of selectees to candidates who did not select that career (non-selectees). Thus, throughout the analyses "aviation selectees" (NAVYAIR) and "pilot selectees" (NPILOT) were compared to non-selectees, respectively.

The results of the preliminary statistical analyses, using T-tests of differences in means, rejected the null hypothesis that there were no differences between the background characteristics of aviation selectees and non-selectees. Additionally, the comparisons of characteristics of "aviation selectees" (NAVY AIR) and "pilot selectees" (NPILOT) as compared to non-selectees, displayed significant differences in means. Furthermore, the logit models and the marginal effects found similar differences in each explanatory variable.

It is important to note that each of the included variables in the secondary model also displayed a greater impact on selection. Most importantly, CAQPR and PFAR were the strongest predictors for "aviation selectees" as well as "pilot selectees" from 1995 to 2002.

B. LIMITATIONS

The thesis has certain limitations. The period covered by the data did not include all candidates to ever select aviation from USNA. Nonetheless, the sample is a strong representation of those selecting aviation under the guidelines in place from 1995 to 2002, a period that incorporated the selection board process, post-combat exclusion period, and prior to extensive corrective eye surgery. Additionally, the data period was conducted largely before corrective eye surgery allowed for previously unqualified personnel to become medically qualified.

Secondly, this study represents candidates who service selected aviation. The data does not account for whether aviation was an individual's first choice of assignment, or for whether they were physically disqualified because of bad eyesight, health, or other reasons. For that reason this study may only be considered valid under the condition of "all other things being considered equal."

C. CONCLUSIONS

The results of this study strongly suggest that from 1995 to 2002 the service assignment process relied more heavily on OOM, its components, and ASTB scores than on other background characteristics. Current aviation service selection personnel at the Naval Academy suggest that during this period the U.S. Naval Academy selection procedures have relied almost solely on academic OOM and ASTB Scores (Roberge, personal communication, 19 July 2002; Lata, personal communication, 02 October, 2002). In part, the narrow selection process may have excluded many additional background characteristics of aviation success and thus decreased the likelihood of selected candidates finishing the flight training process.

For instance, research suggests that flight training success relies heavily on measurable psychomotor skills (Hunter, 1989; English, 1992; Pohlman & Fletcher, 1999; Reinhart, 1998; Reis, 2000; Weeks, 2000; Carretta, 2000; Hedge, Bruskiewicz, Borman, Hansan, & Logan, 2000). While some correlations exist between pure athletic ability and pilot performance, specific skills are most easily quantified by the use of aviation simulators. Currently, the U.S. Navy, unlike the U.S. Air Force, does not employ any

computer-based simulators in the pilot selection process. Unfortunately, beyond varsity athletic participation and physical readiness test (PRT) scores, the U.S. Naval Academy does not quantify many physical or psychomotor characteristics. The results here showed little effect of varsity athletic participation on "aviation" or "pilot" selection. In essence, many background characteristics such as psychomotor abilities may not have been adequately considered in the selection process from 1995 to 2002.

D. RECOMMENDATIONS

The Aviation Selection process is under constant improvement at the U.S. Naval Academy. According to CNET, current pilot selection methods at USNA and other commissioning sources are not producing enough successful aviation candidates (Carey, 2002). The primary consideration of this project was to investigate the significance of specific academic characteristics as predictors of U.S. Naval Academy aviation selection. Based on the results of this study it is recommended that the selection process be reviewed for the possible incorporation of more characteristics that are predictive of aviation training success and to rely less on academic grade point average and ASTB performance.

The Academy has access to a broad spectrum of personal data on each prospective pilot. For example, grades, military performance, academic major, standard cognitive ability test scores, among others, are all readily available to selection boards. Additionally, personal interviews are conducted with each candidate. Although computer-based methods are not employed at USNA, several improvements are conceivable by modeling known predictive characteristics.

It is paramount that the small numbers who are selected for careers in aviation possess the highest probability of success. In an effort to ensure maximum success, it is necessary to base the selection process on the strongest predictive measures possible. While the ASTB is considered to be the single most valuable tool in use today, its utility may be improved by complementing the selection process with additional selective measures. These measures may include academic, psychomotor, and other biographical characteristics of each candidate.

Additionally, the midshipmen clearly begin their journeys toward selection much sooner then their senior year at USNA. It is important to note the additional qualifications that candidates may possess outside of the currently measured characteristics. Prior flight experience and participation in extracurricular flight oriented activities might also greatly contribute to overall flight success. In addition to the obvious importance of prior flight experience, some research suggests that "legacy" information is also predictive of pilot success among naval aviators (Reinhart, 1998; Reis, 2000; Mishoe, 2000). Candidates with prior military enculturation show a higher propensity for success in aviation careers (Mishoe, 2000).

E. FUTURE RESEARCH

It is unknown if the current methods of aviation service assignment at the U.S. Naval Academy are producing a sufficient number of Naval Officers who can successfully complete Naval Flight School. Additional research is recommended to investigate the impact of the factors that predict selection on flight training performance. This study was limited to potential predictors of service assignment and does not predict "aviation success." Further research is recommended to investigate whether factors such as demographics, legacy, athletics, and other cognitive abilities relate to overall success in flight training. In addition, research could be done on the correlation between these and other explanatory variables available at the U.S. Naval Academy.

Additionally, it is recommended that further research be conducted on other officer commissioning sources. An analysis of all military aviation selection methods as related to their overall success is suggested to be the most significant of such studies. It is recommended that all selection sources be examined with respect to the criteria used and their overall relationship to aviation success. Weeks (2000) conducted an in-depth meta-analysis focusing on all points of entry and accession sources for the U.S. Air Force. His central conclusion was that the "Air Force Academy (USAFA) and Reserve Officer Training Corps (ROTC) pilot selection policies may have combined with training factors to increase attrition and flying training costs" (Weeks, 2000, p. v). A similar study conducted on all naval commissioning sources may produce important insights.

Additionally, research could be conducted for other community assignments. It is conceivable to relate similar cognitive abilities as predictors of other service assignments based on the rudimentary argument that job skills demand specific abilities.

Finally, an interesting study may be done regarding aviation selection prediction following graduation year 2001. For example, as technological innovations have improved surgical procedures and medical practices, the instances of physical disqualifications have become less frequent. The "perfect world" or "equal playing field" is rapidly becoming a reality. Medical restrictions on candidates will lessen as technology improves medical procedures and aircraft avionics. Therefore, future studies will be able to better control for such parameters. The reliability of such studies will be much more significant as they will not be affected by constructs such as medical disqualifications. Additionally, as technological advances continue to shape our future, we are possibly at the threshold of predicting pilots and their performance with unprecedented success. It is hoped that this thesis will contribute to other results as a significant data point and a foundation for future studies in order to help expedite the journey toward that goal.

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APPENDIX A. DESCRIPTIVES

Table 27. Descriptives of Background Characteristics of Aviation Selectees

VARIABLE	AVIATION SELECTEES	OTHER	TOTAL	AVIATORS IN SAMPLE	% OF AVIATORS WITH TRAIT
VARATHL	788	1555	2343	2571	31%
MILPAR	569	942	1511	2571	22%
PRI ENL	103	243	346	2571	4%
AC PREP	507	1215	1722	2571	20%

Table 28. Descriptives of Background Characteristics of Pilot Selectees

VARIABLE	PILOT SELECTEES	OTHER	TOTAL	PILOTS IN SAMPLE	% OF PILOTS WITH TRAIT
VARATHL	580	1763	2343	1896	31%
MILPAR	413	1098	1511	1896	22%
PRI ENL	75	271	346	1896	4%
AC PREP	372	1350	1722	1896	20%

Table 29. Percentage Selecting Aviation by Undergraduate Major

Major Code	NFO or Navy Pilot	Other	Total	% of Major Selecting Aviation
Aerospace Engineering	220	121	341	65%
Aerospace Engineering Astronautics	55	43	98	56%
Quantitative Economics	29	40	69	42%
Computer Science	151	234	385	39%
Mechanical Engineering	205	354	559	37%
General Engineering	70	124	194	36%
Systems Engineering	265	483	748	35%
Naval Architecture	45	90	135	33%
Ocean Engineering	140	290	430	33%
Economics	254	507	761	33%
Political Science	331	660	991	33%
History	197	407	604	33%
English	151	327	478	32%
Mathematics	70	158	228	31%
Oceanography	177	386	563	31%
Physics	56	122	178	31%
Electrical Engineering	49	113	162	30%
General Science	51	133	184	28%
Marine Engineering	18	62	80	23%
Chemistry	37	142	179	21%

Table 30. Percentage Selecting Pilot by Undergraduate Major

Undergraduate Major	Navy Pilot	Other	Total	% of Major Selecting Pilot
Aerospace Engineering	165	176	341	48%
Aerospace Engineering Astronautics	42	56	98	43%
Quantitative Economics	24	45	69	35%
Computer Science	117	268	385	30%
Mechanical Engineering	157	402	559	28%
Systems Engineering	198	550	748	26%
Physics	46	132	178	26%
General Engineering	49	145	194	25%
Naval Architecture	34	101	135	25%
Economics	194	567	761	25%
Oceanography	133	430	563	24%
Electrical Engineering	38	124	162	23%
Ocean Engineering	101	329	430	23%
Political Science	230	761	991	23%
English	112	366	478	23%
History	137	467	604	23%
Mathematics	50	178	228	22%
General Science	33	151	184	18%
Marine Engineering	12	68	80	15%
Chemistry	24	155	179	13%

Table 31. Number of Aviation Selectees by Major Group

Undergraduate Major Groups	NFO or Navy Pilot	Other	Total
Group I-Engineering	1067	1680	2747
Group II-Science/Math	571	1215	1786
Group III-Humanities/Social Science	933	1901	2834
Total	2571	4796	7367

Table 32. Number of Pilot Selectees by Major Group

Undergraduate Major Groups	Navy Pilot	Other	Total
Group I-Engineering	796	1951	2747
Group II-Science/Math	427	1359	1786
Group III-Humanities/Social Science	673	2161	2834
Total	1896	5471	7367

APPENDIX B. MARGINAL EFFECTS FROM LOGIT REGRESSION COEFFICIENTS

To observe the behavioral relationships of each independent variable in the models, marginal effects (ME) were calculated. The marginal effect tables listed in this appendix calculate the change in probability of the dependent variable (NAVYAIR or NPILOT) for one-unit change in each of the explanatory variables. For this study, Bowman's (1998) econometric theory applied logit regression techniques to models in order to observe the impact of each independent variable on the probability of the outcome of aviation selection occurring. Thus, the degree to which these characteristics impact selection of aviators and pilots was examined.

Using SPSS software in conjunction with Excel spreadsheets, the following tables were used to calculate the marginal effects and overall probability of the models. Below is a description of each table.

COLUMN:	DESCRIPTION:
"VARIABLE"	The name of each explanatory variable used in the model
"XBAR"	The arithmetic mean of the variable in the model
"LOGIT"	The logit coefficient (β) from the regression output of SPSS
"X*LOGIT"	Mathematic result of XBAR multiplied with LOGIT
"LOGIT*P(1-P)"	Mathematic result representing the marginal effect of the variable, within the model.
"P=1/(1+e^-Z)"	Mathematic result representing the overall probability of the model give the current values of each explanatory variable.

Table 33. Primary Model (NAVYAIR) Marginal Effects

LOGIT MODEL SPECIFICATIONS

				MARGINAL	Z=S(X*LOGIT)
VARIABLE	**XBAR**	**LOGIT**	**X*LOGIT**	**LOGIT*P(1-P)**	-0.9192
Constant	1	-3.449	-3.449	-0.702998846	**P=1/(1+e^-Z)**
CMQPR	3.1844	-0.084	-0.26749	-0.017121456	**0.285121**
CAQPR	2.9409	0.198	0.582298	0.040357719	
VAR ATHL	0.3	0.047	0.0141	0.009579863	
MIL PAR	0.22	0.177	0.03894	0.036077355	
PRI ENL	0.05	-0.294	-0.0147	-0.059925097	
AC PREP	0.22	-0.126	-0.02772	-0.025682185	
MAJ GRP 1	1.99	-0.15	-0.2985	-0.030574029	
MAJ GRP 2	1.99	-0.165	-0.32835	-0.033631432	
AQR	5.62	-0.071	-0.39902	-0.014471707	
PFAR	5.24	0.299	1.56676	0.060944232	
FOFAR	5.5	0.007	0.0385	0.001426788	
PBI	6.58	0.156	1.02648	0.03179699	
FOBI	6.65	0.09	0.5985	0.018344418	

Table 34. Primary Model (NPILOT) Marginal Effects

LOGIT MODEL SPECIFICATIONS

				MARGINAL	Z=S(X*LOGIT)
VARIABLE	**XBAR**	**LOGIT**	**X*LOGIT**	**LOGIT*P(1-P)**	-1.28383
Constant	1	-4.321	-4.321	-0.7339368	**P=1/(1+e^-Z)**
CMQPR	3.1821	0.087	0.2768427	0.01477725	**0.216898**
CAQPR	2.9371	0.247	0.7254637	0.04195381	
VAR ATHL	0.3	0.012	0.0036	0.00203824	
MIL PAR	0.22	0.125	0.0275	0.02123168	
PRI ENL	0.05	-0.284	-0.0142	-0.0482384	
AC PREP	0.22	-0.086	-0.01892	-0.0146074	
MAJ GRP 1	1.99	-0.131	-0.26069	-0.0222508	
MAJ GRP 2	1.99	-0.107	-0.21293	-0.0181743	
AQR	5.61	-0.06	-0.3366	-0.0101912	
PFAR	5.24	0.31	1.6244	0.05265457	
FOFAR	5.5	-0.037	-0.2035	-0.0062846	
PBI	6.59	0.17	1.1203	0.02887509	
FOBI	6.65	0.046	0.3059	0.00781326	

Table 35. Secondary Model (NAVYAIR) Marginal Effects

LOGIT MODEL SPECIFICATIONS					
				MARGINAL	Z=S(X*LOGIT)
VARIABLE	XBAR	LOGIT	X*LOGIT	LOGIT*P(1-P)	-0.37234
Constant	1	-3.458	-3.458	-0.83522	P=1/(1+e^-Z)
CMQPR	3.1821	-0.108	-0.34367	-0.02609	**0.407976**
CAQPR	2.9371	0.239	0.701967	0.057726	
AQR	5.61	-0.098	-0.54978	-0.02367	
PFAR	5.24	0.298	1.56152	0.071976	
FOFAR	5.5	0.021	0.1155	0.005072	
PBI	6.59	0.153	1.00827	0.036954	
FOBI	6.65	0.089	0.59185	0.021496	

Table 36. Secondary Model (NPILOT) Marginal Effects

LOGIT MODEL SPECIFICATIONS					
				MARGINAL	Z=S(X*LOGIT)
VARIABLE	XBAR	LOGIT	X*LOGIT	LOGIT*P(1-P)	-0.88625
Constant	1	-4.298	-4.298	-0.888343555	P=1/(1+e^-Z)
CMQPR	3.1821	0.057	0.18138	0.011781197	**0.291884**
CAQPR	2.9371	0.28	0.822388	0.057872544	
AQR	5.61	-0.082	-0.46002	-0.016948388	
PFAR	5.24	0.31	1.6244	0.064073174	
FOFAR	5.5	-0.026	-0.143	-0.005373879	
PBI	6.59	0.165	1.08735	0.034103464	
FOBI	6.65	0.045	0.29925	0.009300945	

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APPENDIX C. MARGINAL EFFECTS OF CONTINGENCY MODELS

Table 37. Marginal Effect Contingencies of Primary Model (NAVYAIR)

Lower Candidate

VARIABLE	XBAR	LOGIT	X*LOGIT	MARGINAL LOGIT*P(1-P)	Z=S(X*LOGIT)
					-2.74
Constant	1	-3.449	-3.449	-0.702998846	P=1/(1+e^-Z)
CMQPR	2	-0.084	-0.168	-0.017121456	0.060654
CAQPR	2	0.198	0.396	0.040357719	
VAR ATHL	0	0.047	0	0.009579863	
MIL PAR	0	0.177	0	0.036077355	
PRI ENL	0	-0.294	0	-0.059925097	
AC PREP	0	-0.126	0	-0.025682185	
MAJ GRP 1	0	-0.15	0	-0.030574029	
MAJ GRP 2	0	-0.165	0	-0.033631432	
AQR	1	-0.071	-0.071	-0.014471707	
PFAR	1	0.299	0.299	0.060944232	
FOFAR	1	0.007	0.007	0.001426788	
PBI	1	0.156	0.156	0.03179699	
FOBI	1	0.09	0.09	0.018344418	

Average Candidate

LOGIT MODEL SPECIFICATIONS:					
VARIABLE	XBAR	LOGIT	X*LOGIT	MARGINAL LOGIT*P(1-P)	Z=S(X*LOGIT)
					-0.9192
Constant	1	-3.449	-3.449	-0.702998846	P=1/(1+e^-Z)
CMQPR	3.1844	-0.084	-0.26749	-0.017121456	0.285121
CAQPR	2.9409	0.198	0.582298	0.040357719	
VAR ATHL	0.3	0.047	0.0141	0.009579863	
MIL PAR	0.22	0.177	0.03894	0.036077355	
PRI ENL	0.05	-0.294	-0.0147	-0.059925097	
AC PREP	0.22	-0.126	-0.02772	-0.025682185	
MAJ GRP 1	1.99	-0.15	-0.2985	-0.030574029	
MAJ GRP 2	1.99	-0.165	-0.32835	-0.033631432	
AQR	5.62	-0.071	-0.39902	-0.014471707	
PFAR	5.24	0.299	1.56676	0.060944232	
FOFAR	5.5	0.007	0.0385	0.001426788	
PBI	6.58	0.156	1.02648	0.03179699	
FOBI	6.65	0.09	0.5985	0.018344418	

Perfect Candidate

VARIABLE	XBAR	LOGIT	X*LOGIT	MARGINAL LOGIT*P(1-P)	Z=S(X*LOGIT)
					0.99
Constant	1	-3.449	-3.449	-0.702998846	P=1/(1+e^-Z)
CMQPR	4	-0.084	-0.336	-0.017121456	0.729088
CAQPR	4	0.198	0.792	0.040357719	
VAR ATHL	1	0.047	0.047	0.009579863	
MIL PAR	1	0.177	0.177	0.036077355	
PRI ENL	1	-0.294	-0.294	-0.059925097	
AC PREP	1	-0.126	-0.126	-0.025682185	
MAJ GRP 1	1	-0.15	-0.15	-0.030574029	
MAJ GRP 2	0	-0.165	0	-0.033631432	
AQR	9	-0.071	-0.639	-0.014471707	
PFAR	9	0.299	2.691	0.060944232	
FOFAR	9	0.007	0.063	0.001426788	
PBI	9	0.156	1.404	0.03179699	
FOBI	9	0.09	0.81	0.018344418	

Table 38. Marginal Effect Contingencies of Primary Model (NPILOT)

Lower Candidate

VARIABLE	XBAR	LOGIT	X*LOGIT	MARGINAL LOGIT*P(1-P)	Z=S(X*LOGIT)
					-3.224
Constant	1	-4.321	-4.321	-0.7339368	P=1/(1+e^-Z)
CMQPR	2	0.087	0.174	0.01477725	0.038272
CAQPR	2	0.247	0.494	0.04195381	
VAR ATHL	0	0.012	0	0.00203824	
MIL PAR	0	0.125	0	0.02123168	
PRI ENL	0	-0.284	0	-0.0482384	
AC PREP	0	-0.086	0	-0.0146074	
MAJ GRP 1	0	-0.131	0	-0.0222508	
MAJ GRP 2	0	-0.107	0	-0.0181743	
AQR	1	-0.06	-0.06	-0.0101912	
PFAR	1	0.31	0.31	0.05265457	
FOFAR	1	-0.037	-0.037	-0.0062846	
PBI	1	0.17	0.17	0.02887509	
FOBI	1	0.046	0.046	0.00781326	

Average Candidate

LOGIT MODEL SPECIFICATIONS:

VARIABLE	XBAR	LOGIT	X*LOGIT	MARGINAL LOGIT*P(1-P)	Z=S(X*LOGIT)
					-1.28383
Constant	1	-4.321	-4.321	-0.7339368	P=1/(1+e^-Z)
CMQPR	3.1821	0.087	0.2768427	0.01477725	0.216898
CAQPR	2.9371	0.247	0.7254637	0.04195381	
VAR ATHL	0.3	0.012	0.0036	0.00203824	
MIL PAR	0.22	0.125	0.0275	0.02123168	
PRI ENL	0.05	-0.284	-0.0142	-0.0482384	
AC PREP	0.22	-0.086	-0.01892	-0.0146074	
MAJ GRP 1	1.99	-0.131	-0.26069	-0.0222508	
MAJ GRP 2	1.99	-0.107	-0.21293	-0.0181743	
AQR	5.61	-0.06	-0.3366	-0.0101912	
PFAR	5.24	0.31	1.6244	0.05265457	
FOFAR	5.5	-0.037	-0.2035	-0.0062846	
PBI	6.59	0.17	1.1203	0.02887509	
FOBI	6.65	0.046	0.3059	0.00781326	

Perfect Candidate

VARIABLE	XBAR	LOGIT	X*LOGIT	MARGINAL LOGIT*P(1-P)	Z=S(X*LOGIT)
					0.512
Constant	1	-4.321	-4.321	-0.7339368	P=1/(1+e^-Z)
CMQPR	4	0.087	0.348	0.01477725	0.625275
CAQPR	4	0.247	0.988	0.04195381	
VAR ATHL	1	0.012	0.012	0.00203824	
MIL PAR	1	0.125	0.125	0.02123168	
PRI ENL	1	-0.284	-0.284	-0.0482384	
AC PREP	1	-0.086	-0.086	-0.0146074	
MAJ GRP 1	1	-0.131	-0.131	-0.0222508	
MAJ GRP 2	0	-0.107	0	-0.0181743	
AQR	9	-0.06	-0.54	-0.0101912	
PFAR	9	0.31	2.79	0.05265457	
FOFAR	9	-0.037	-0.333	-0.0062846	
PBI	9	0.17	1.53	0.02887509	
FOBI	9	0.046	0.414	0.00781326	

Table 39. Marginal Effect Contingencies of Secondary Model (NAVY AIR)

Lower Candidate

VARIABLE	XBAR	LOGIT	X*LOGIT	MARGINAL LOGIT*P(1-P)	Z=S(X*LOGIT)
					-2.733
Constant	1	-3.458	-3.458	-0.83522	P=1/(1+e^-Z)
CMQPR	2	-0.108	-0.216	-0.02609	0.061054
CAQPR	2	0.239	0.478	0.057726	
AQR	1	-0.098	-0.098	-0.02367	
PFAR	1	0.298	0.298	0.071976	
FOFAR	1	0.021	0.021	0.005072	
PBI	1	0.153	0.153	0.036954	
FOBI	1	0.089	0.089	0.021496	

Average Candidate

LOGIT MODEL SPECIFICATIONS:

VARIABLE	XBAR	LOGIT	X*LOGIT	MARGINAL LOGIT*P(1-P)	Z=S(X*LOGIT)
					-0.37234
Constant	1	-3.458	-3.458	-0.83522	P=1/(1+e^-Z)
CMQPR	3.1821	-0.108	-0.34367	-0.02609	0.407976
CAQPR	2.9371	0.239	0.701967	0.057726	
AQR	5.61	-0.098	-0.54978	-0.02367	
PFAR	5.24	0.298	1.56152	0.071976	
FOFAR	5.5	0.021	0.1155	0.005072	
PBI	6.59	0.153	1.00827	0.036954	
FOBI	6.65	0.089	0.59185	0.021496	

Perfect Candidate

VARIABLE	XBAR	LOGIT	X*LOGIT	MARGINAL LOGIT*P(1-P)	Z=S(X*LOGIT)
					1.233
Constant	1	-3.458	-3.458	-0.83522	P=1/(1+e^-Z)
CMQPR	4	-0.108	-0.432	-0.02609	0.774343
CAQPR	4	0.239	0.956	0.057726	
AQR	9	-0.098	-0.882	-0.02367	
PFAR	9	0.298	2.682	0.071976	
FOFAR	9	0.021	0.189	0.005072	
PBI	9	0.153	1.377	0.036954	
FOBI	9	0.089	0.801	0.021496	

Table 40. Marginal Effect Contingencies of Secondary Model (NPILOT)

Lower Candidate

LOGIT MODEL SPECIFICATIONS					
				MARGINAL	Z=S(X*LOGIT)
VARIABLE	XBAR	LOGIT	X*LOGIT	LOGIT*P(1-P)	-3.212
Constant	1	-4.298	-4.298	-0.888343555	P=1/(1+e^-Z)
CMQPR	2	0.057	0.114	0.011781197	0.038717
CAQPR	2	0.28	0.56	0.057872544	
AQR	1	-0.082	-0.082	-0.016948388	
PFAR	1	0.31	0.31	0.064073174	
FOFAR	1	-0.026	-0.026	-0.005373879	
PBI	1	0.165	0.165	0.034103464	
FOBI	1	0.045	0.045	0.009300945	

Average Candidate

LOGIT MODEL SPECIFICATIONS					
				MARGINAL	Z=S(X*LOGIT)
VARIABLE	XBAR	LOGIT	X*LOGIT	LOGIT*P(1-P)	-0.88625
Constant	1	-4.298	-4.298	-0.888343555	P=1/(1+e^-Z)
CMQPR	3.1821	0.057	0.18138	0.011781197	0.291884
CAQPR	2.9371	0.28	0.822388	0.057872544	
AQR	5.61	-0.082	-0.46002	-0.016948388	
PFAR	5.24	0.31	1.6244	0.064073174	
FOFAR	5.5	-0.026	-0.143	-0.005373879	
PBI	6.59	0.165	1.08735	0.034103464	
FOBI	6.65	0.045	0.29925	0.009300945	

Perfect Candidate

LOGIT MODEL SPECIFICATIONS					
				MARGINAL	Z=S(X*LOGIT)
VARIABLE	XBAR	LOGIT	X*LOGIT	LOGIT*P(1-P)	0.758
Constant	1	-4.298	-4.298	-0.888343555	P=1/(1+e^-Z)
CMQPR	4	0.057	0.228	0.011781197	0.680919
CAQPR	4	0.28	1.12	0.057872544	
AQR	9	-0.082	-0.738	-0.016948388	
PFAR	9	0.31	2.79	0.064073174	
FOFAR	9	-0.026	-0.234	-0.005373879	
PBI	9	0.165	1.485	0.034103464	
FOBI	9	0.045	0.405	0.009300945	

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